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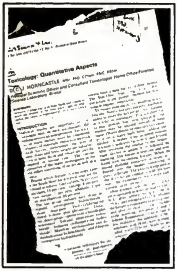

Toxicology: Quantitative Aspects

D C J HORNCASTLE

Principal Scientific Officer and Consultant Toxicologist Home Office Forensic Science Laboratory Bristol

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COMMENT

NASA's high noon

THE MOOD at NASA is bleak. The space agency did not grouse when President Reagan, for the "national good", cut into its plans for the rest of the decade. But an aura of frustration is unmistakable. Reagan's financial policies have injected an element of uncertainty into the financial equation, and for undertakings that require several years of advance planning, uncertainty is anathema.

Now that mood of uncertainty has spread to Europe. Despite years of planning and millions of dollars spent by NASA and its European counterpart, the European Space Agency (ESA), and despite the pleas of the scientific community, the White House will not reverse its decision to withhold from NASA the money it needs to mount a joint mission with ESA to send two satellites around the Sun. A panel of experts from the government's scientific oracle, the National Academy of Sciences, looked at some cheaper alternatives to the original idea of two satellites. But it concluded that, dollar for dollar, the original plan is the best (page 6). Space scientists and engineers inside and outside NASA are embarrassed by the government's intractability. Frank Press, Jimmy Carter's science adviser and now head of the academy, pointedly warns that scientists in other countries may come to see the US as an unreliable partner. George Keyworth, Reagan's science adviser, told *New Scientist* in a recent interview that one of his priorities is to encourage international cooperation in big, expensive ventures such as the exploration of space. Lately, Keyworth has been silent about the solar mission.

Reagan is right; the US cannot afford to run into debt, and NASA must endure its share of austerity along with the others. But NASA and ESA's two-man relay can cover ground faster than a lone runner. Unfortunately for all concerned, the US may not have anyone to pick up the baton. ☐

Science of Labour

FOR the first time since Harold Wilson made his famous "white heat of technology" speech in 1963, it looks as if science and technology could play an important role in a general election. All the signs at this week's Labour Party conference point to the conclusion that the party might go into the next general election with thought-out policies on science and technology. For example, a fringe meeting at the conference on Tuesday evening heard Tam Dalyell, the shadow spokesman on science, hold out several promises that indicate the shape government policies might take. (The very fact that the opposition have a spokesman on science, while the government does not, is more than suggestive.)

One thing is certain about any policy for science and technology that the Labour Party might adopt—it will not be a repeat of Wilson's technocratic vision. As Dalyell said on Tuesday, "We couldn't have the white heat of technology again, if only because, to put it at its lowest, no-one would believe us." And to be sure the world—and its opinion of science—has changed since 1963. The central element in a Labour policy on science could well be the question of who runs science. More radical voices at Tuesday's fringe meeting, such as Steven Rose, professor of biology at the Open University, were talking of wresting control of science out of the hands of those now exercising it—"the very tiny minority of people", on the whole unresponsive to pressure from below, from the community, or from parliament. That would mean making the structures that control science accountable.

Perhaps more centrally, Dalyell looks like taking up the idea that to direct science and technology, a Labour government must tackle the thorny problem of defence research, which consumes about half of the money Britain spends on science and technology. He admitted that in the past two Labour governments "defence science has been taboo" and he promised that "next time around, it is important that the central decision is taken at the very top of the government" to unlock these resources. No doubt this is an opinion that will appeal to the unilateralist Michael Foot.

Whether the other elements that seem to be coming together to form a Labour policy on science and technology are similarly appealing to a party in power remain to be seen. But not for a long time have the signs been so favourable. Whether scientists will agree or disagree with a Labour science policy, they will at least know that the party has one. ☐

Forensic scientists defend 'deranged' dissident

A NEW row is developing over the sacked Home Office forensic scientist Colin Horncastle. Horncastle was dismissed after publishing an academic paper which Home Office experts described as "farcical" and the work of a "deranged mind". But independent forensice experts say that although the paper is not good there is nothing in it to warrant these comments.

Horncastle first gave the paper, called *Toxicology: quantitative aspects* at an internal Home Office seminar in 1969, which was chaired by Dr Alan Curry. In 1973 Horncastle submitted the paper for publication and it appeared in *Medicine, Science and Law* in January 1977.

Curry, who was by now the head of the Home Office's Forensic Science Service sent the paper to six experts. They damned it. One, Dr A. C. Moffat wrote: "This is an appallng paper . . . the calculation and computer programmes as presented are farces . . .

"I am dismayed that a member of the Forensic Science Service wrote this and similarly disgusted with the journal for printing it. I can find no redeeming features."

And George Walker, who is director of the Home Office's Chorley laboratory wrote: "It appears to be the product of a deranged mind."

New Scientist sent Horncastle's paper to David Patterson, a past president of the Forensic Science Society. Patterson read the paper and consulted colleagues before telling *New Scientist:* "It is not a terribly good paper but there is nothing in it to incur wrath on this scale. There is no reason for these . . . comments." Other independent toxicologists agree with this.

New Scientist asked Walker why he thought the paper was "the product of a deranged mind." Walker said he did not have the paper or his comments to hand. "I really have no comment on that."

David G. Hodge

Curry (above) thought Horncastle was mentally ill. Other scientists disagree

Horncastle's paper tries to establish a link between the amount of drugs in the organs of people who died from poisoning and the time since the drugs were taken. Horncastle concludes that the absorption of drugs obeys a diffusion law known as Fick's law, named after the German physiologist Adolph Fick, who died in 1901.

Mick Hamer

Horncastle says that the Home Office was upset because his paper suggested that forensic scientists analyse organs other than the liver and blood, which the Home Office prefers. The Home Office's Bristol laboratory, where Horncastle used to work, prefers analysing other body organs. Horncastle says his paper shows that other body organs are as good indicators as the liver and blood.

One particular passage in the paper seems to have annoyed the Home Office. Horncastle wrote: "A pessimistic view is that it is impossible to remove the last vestiges of alchemy from toxicology because of the nature of the material for analysis. It may be, apart from the fact of death, that one cannot be absolutely certain of anything . . ."

In his early days at the Home Office—he joined in 1966—Horncastle had good annual reports. But a month after the article appeared, a Mr Platt of the Home Office's personnel department wrote to Horncastle taking him off court work: "Furthermore I am advised that the quality of the article calls into question your competence to submit evidence to court."

He was removed from casework and put onto research. Horncastle then issued a writ for defamation against Platt, which he has yet to pursue. Two months later Alan Curry wrote on his annual report: "I have taken Dr Horncastle off case work as I believe he is mentally ill." He was then sent before a retirement board. The Home Office wanted to retire him on grounds of "inefficiency". Horncastle says that the retirement board "found for me, to retain me in my present grade".

In 1980 the Home Office offered Horncastle a teaching post at the same salary as his previous job. He turned it down because it was a demotion. In April he was given nine week's notice, which is normal for people being retired on medical grounds, for breaking his contract by refusing the job.

At an industrial tribunal he lost his fight to keep his job, but he did discover for the first time that the Home Office was making allegations of mental illness. Horncastle has never been mentally ill. He said of the allegations: "I don't think you can sink any lower."

Horncastle added that his former boss at Bristol supports him and that "There has been a lot of bloody-mindedness and professional jealousy. There is a great deal of personalities about this. A more sensitive controller [Curry is the controller] would have avoided all the nastiness."

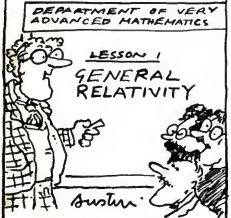
This is the second public row this year involving a forensic scientist. Last month the Home Office retired Alan Clift, 54, because of "limited efficiency". Clift was suspended on full pay in 1977 following an internal check. He has decided not to appeal against his dismissal because of the effect a long drawn out battle would have on his family.

There is one further link between Clift and Horncastle. One of the cases where Clift's work was criticised concerned three men convicted of burglary. It came to appeal in 1978—after Clift had been suspended. Clift's evidence at the original trial suggested that one suspect's shoe matched a plaster cast of a footprint. On appeal, two Home Office experts said the print did not match the cast, and that Clift could not possibly have identified the suspects from them.

However, someone had destroyed the plaster casts between the trial and the appeal, and the experts came to their conclusion by comparing photographs—thus making their judgement in two dimensions, not in three. One of these experts was George Walker.

The Clift case has had repercussions for the Forensic Science Society, of which Clift is a founder member and treasurer. Now Home Office forensic scientists have called an extraordinary general meeting to discuss the Clift case, and to remove Clift's supporters from the society's council. Clift has already decided that he will not stand again as treasurer. ☐

Observer


DEPARTMENT OF VERY ADVANCED MATHEMATICS
LESSON 1
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Austin

"And when you've mastered that we'll go on to the Labour Party electoral system."

Deafening silence from genetic engineers about commercial threats

Stephanie Yanchinski

GENETIC engineers meeting in Rome last week to discuss the threats and promises raised by the commercialisation of their science were strangely silent about the hottest issues. Most of the 100 molecular biologists at the meeting said nothing about the threat of private money jeopardising the integrity of research in genetic engineering. One who did speak out, George Cahill, the research director of the Howard Hughes Medical Institute, had hard words to say: "the public," he claimed, "is disenchanted with the biomedical establishment because the scientific community is now moved more by profit than by conscience".

The meeting was the second organised by Cogene—the Committee on Genetic Experimentation, a subcommittee of the International Council for Scientific Unions. There was talk before the meeting that Cogene might disband, having succeeded, with its first meeting two years ago, in raising the issue of the safety of genetic engineering. And this second meeting failed to come to grips with many of the problems raised by the "intrusion" of commerce into genetic engineering.

Dr Norton Zinder of Rockefeller University compared this intrusion to a virus, which initially stimulates growth but then devours its host. Jeffrey Miller, a young American molecular biologist from Geneva University was one of the few who took up this theme. Miller feels so strongly about the dangers to molecular biology research that he took *Nature* to the British Press Council for refusing to publish an article he wrote on the issue. The Press Council's judgement was in *Nature's* favour. It revealed, however, that before declining to publish the article, *Nature* had sent a copy of it for correction to Charles Weissmann who works in Geneva University and is a director of the genetic engineering company Biogen. Miller had strongly criticised Weissmann in his article.

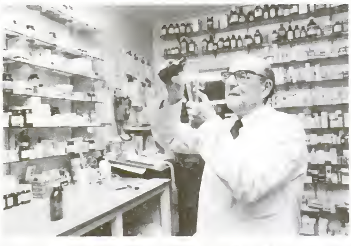
Miller objected to Weissmann offering a large cash bonus to the first scientist to clone interferon. Miller says that when he first told colleagues of the offer, almost all expressed dismay. Now they just shrug their shoulders.

Weissmann was not in the audience to hear Miller's charges but he had stoutly defended his department's contract with Biogen the night before. He said that only companies like Biogen could afford to finance the later stages of projects such as the cloning of interferon. He said: "We all enjoy publicity which allows us to retain tenure and get grants or a Nobel prize. The profit motive is just one more impurity in this mixture."

Practically everyone at the meeting agreed that universities will have to rely more and more on industrial finance as the flood of government money that engulfed universities in the 1960s dries up. But it was obvious that few are coming to grips with the problems industrial financing can raise. Perhaps the lack of discussion at last week's Rome meeting was because there is no consensus among scientists about what should be done. Or perhaps, as Miller suggested, "we are discussing the issue two years too late".

However one set of guidelines did emerge at the meeting—from Irving Johnson, Eli Lilly's director of R&D. He suggested, for example, that biological materials should be freely exchanged among scientists but not passed to commercial interests. Dr Stanley Cohen of Stanford University and a member of Cogene's scientific advisory board, told *New Scientist* that Cogene would consider drawing up similar guidelines, perhaps based, in part, on Johnson's. ☐

Doctors plan to take cancer drugs off the shelf


Pete Addis

Cancer researchers want a short cut to the patient

PROPOSALS that could double the number of anti-cancer drugs tested every year are under scrutiny by the Committee on Safety of Medicines, the watchdog that protects patients against the side-effects of drugs. The proposals come from a special committee the Cancer Research Campaign set up. In essence, they make a special case for anti-cancer drugs, suggesting that their safety should be tested only in mice (not in several species of mammal as the current regulations stipulate).

The Cancer Research Campaign's committee was worried that every year hundreds of drugs that might be effective in combating cancer are left on the shelf because it would be too expensive to test their safety. Currently, the Committee on Safety on Medicines makes it easier for individual physicians to try out anti-cancer drugs on their own patients than for a drug company to mount clinical trials of such drugs. But safety tests on a range of animals, usually rodents and a larger species such as dogs or monkeys, still have to precede treatment with new anti-cancer drugs. This is costly—as much as £50 000 per compound tested.

The campaign's committee does not think that its proposals will increase the risk of toxic side-effects to cancer patients. Dr Tom Connors, chairman of the committee and director of the Medical Research Council's Toxicology Unit, said: "This does not mean experimenting on patients. Recent research from the United States has shown that the mouse is an excellent predictor of toxicity. It is as good as monkeys or dogs".

Ironically, while tests on some animals are good at predicting toxic side-effects, they are not such good guides to a drug's effectiveness. Yet the high cost of toxicology means that the few drugs that reach human trials are those that are most active in these tests.

Connors said: "Contemporary drugs are, for the most part, very similar to those that were produced in the 1950s".

So the Cancer Research Campaign's new scheme would increase not only the number of new drugs tested in humans but also give doctors new types of drug to try. Some drugs that never progress to being tried in humans—because they are not spectacular in animal tests—might turn out to be very effective in man.

Dr Edward Newlands of the Department of Medical Oncology at the Charing Cross Hospital in London said that the campaign's new rules would halve the cost of animal testing and increase the number of new drugs tried in man from three or four a year to about 10. He said the idea behind the proposals was "to limit the costs of testing per compound, until you know that you have got something useful. There is no point on spending a fortune on animal testing if the drug is useless in humans".

The US might also be a source of new anti-cancer drugs. Legislation governing the safety testing of drugs is even stricter there. Dr Newlands explained that the US National Cancer Institute is prepared to send new drugs to Britain and Europe for testing. "They have already sent three to the UK this year and it is hoped that they will send more under the new enterprise". ☐

Day of reckoning for London's third airport

Roger Milne

THE GROUNDS of a 17th century mansion complete with a famous avenue of mature lime trees and a flourishing herd of fallow deer this week provide an incongruous backdrop for the latest in a line of attempts to decide where—and when—to build the third London airport.

On Tuesday, Mr Graham Eyre, a rather crusty planning barrister, opened simultaneous public inquiries into four proposals to build a major new airport to handle 15 million passengers a year at one of four places: Stansted Airport in Essex; Heathrow Airport; the Severn Estuary; and Maplin Sands, off the South Essex coast. The inquiries are being held in a specially erected temporary building in the grounds of Quendon Hall, at Bishop's Stortford in Hertfordshire. The proceedings threaten to be a marathon affair with sittings stretching well into 1982 and a legion of participants.

But it is a moot point whether this third attempt to settle the issue will be any more successful than the two before it.

Stansted Airport, a US air base in wartime, is favoured by the British Airports Authority. But it was rejected after a previous inquiry in the mid-1960s, and turned down by the Roskill Commission in 1971. It is still a front runner because of strong support from the Department of Trade in its favour.

But the circumstances that destroyed its chances earlier are still a potent force today. They are a mixture of environmental and political objections, strongly laced with that hidden ingredient which has bedevilled strategic planning in Britain—the predeliction of successive governments to side-step decisions. And that possibility is available this time round—should the government decide to put off a decision—in the shape of the latest statistics on air traffic that the Department of Trade issues.

Last month, there were press leaks of a furious row inside the Air Traffic Forecasting Working Party, composed of aviation interests and representatives of central and local government. According to figures the Department of Trade's statisticians produced, the lowest estimate of the number of people who will be using London's airports in the year 2000 is 67 million passengers a year—25 million more than at present.

Significantly for the inquiry now under way, that figure represents the expected capacity at London's airports once the expansions now planned take place (that is, Heathrow's fourth terminal, additional traffic at Stansted and Luton, and a second terminal at Gatwick). In other words, or so it will be argued at Quendon, there is no need for any extra big airport until the next century. And with the recession sharply hitting the traffic the world's airlines carry at present, that argument will have a forceful ring.

The supporters of Stansted will mount a strong case on the grounds of the likely boost to jobs the airport would bring to the Greater London area—perhaps as many as 20 000. They also point to the presence of the recently extended M11 motorway and to plans to electrify the nearest railway link. But most crucial to their argument is the fact that developing Stansted is a matter of extending an existing airport rather than building a new one, which could involve major land reclamation and, as a result, longer construction times. Both Maplin and Severnside are new sites.

Environmentally, however, the Severnside and Maplin alternatives have superficially attractive arguments in their favour, both on the grounds of noise (Maplin was the site the Noise Advisory Council preferred) and because neither would mean anything like the loss of good agricultural land that Stansted would entail. The Ministry of Agriculture, Fisheries and Food is objecting to Stansted because of the threat it poses to farming, and the Department of the Environment admits that development there would drive a coach and horses through agreed policy on regional planning, which sees the area as part of the green belt.

The prospect of Heathrow—in the guise of a fifth terminal—as the alternative to Stansted is rather remote, despite the advocacy of British Airways and the local planning authorities around Stansted. Politically, growth at Heathrow would prove highly contentious because noise levels there are already too high.

Underpinning the debate over the rival sites is another powerful line of argument: the question of regional policy. A consortium of northern interests and local authorities are arguing that it would be more rational—and equitable—to expand airports in the North rather than plough yet more public investment into an airport in the favoured South East.

That is an argument also advanced by Gwent County Council, which backs the Severnside option. And it will be echoed by the most vociferous of the groups fighting the prospect of a third airport at Stansted, the North West Essex and East Herts Preservation Association.

They are retaining Sir Collin Buchanan, the maverick Roskill Commissioner, as one of their key witnesses. He believes that Maplin was the best choice back in 1971 and saw his judgement backed by the government of the day which set up a Maplin Development Agency to build an airport—and sea port—off the South Essex coast. That project was killed in 1974. But Buchanan believes that neither the Department of Trade nor the British Airports Authority has learnt the lesson the earlier campaigns appeared to prove—that any inland airport site is now too politically contentious to be acceptable. ☐

This One
3XZR-PBH-A3QW

Pete Addis

Stansted is front runner—but the neighbours don't like it

THIS WEEK

End of the line for joint mission to the Sun

THE PROSPECT of reviving American participation in a joint US/European mission to send two satellites around the Sun looked dimmer than ever this week, despite a plea from the chairman of the US National Academy of Sciences and a report from the academy recommending that NASA should stay in the project.

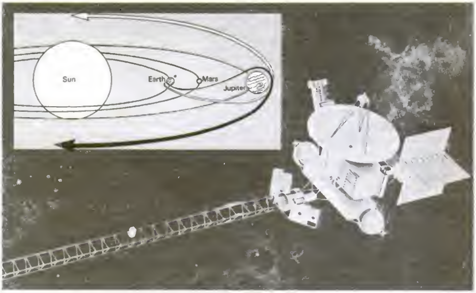
In his second pruning of the Federal budget this year, President Reagan called for a 12 per cent cut in the spending of all government agencies, except the Department of Defense, during the financial year that began on 1 October. There is little hope at NASA that the agency can even scrape together enough loose change to play some role—however small—in the joint venture.

Christopher Joyce, Washington DC

The project—the International Solar Polar Mission—was to have involved NASA and the European Space Agency sending two satellites around the Sun. NASA would have built one, ESA the other. Now NASA has no hope of building its satellite or of buying one from the European agency (at $40 million, a cheaper option).

Last June, Congress momentarily breathed some life back into the mission by authorising NASA to spend $3 million to keep preparations for it ticking over. This summer, the House of Representatives narrowly passed a bill giving NASA $70 million for 10 projects, including the Solar Polar Mission. But the White House was hostile to the bill and the Senate has yet to consider it.

While the mission was being tossed about on Capitol Hill, the National Academy of Sciences was, at Congress's request, analysing the scientific merits of four alternatives to the original joint plan. A panel of the academy's space science boards has now concluded that the original plan would bring the greatest scientific rewards, dollar for dollar.



ESA

ESA's spacecraft will travel alone over the pole of the Sun

Frank Press, chairman of the academy, passed the report to Congress, also delivering some of the political sentiments the report left unsaid. "The potential harm of our action on future international cooperative ventures, not only in space exploration but in all matters of cooperative scientific investigation, cannot be over-emphasised," Press wrote. He advised that at a time of financial austerity when Europe and Japan are pushing ahead in space exploration and high-energy physics, the US cannot afford to be seen as an "unreliable partner".

Apparently, the academy's report and Press's warnings have come too late to sway the White House. James Beggs, NASA's administrator, reportedly decided not to ask the White House for any funds during the 1983 financial year for an American craft to take part in the mission.

A group of ESA officials meets today (Thursday) to decide how to proceed with the solar polar mission in the light of NASA's refusal to provide a second spacecraft. The agency's scientific and technical committee will consider whether to go ahead with only one spacecraft, which ESA is already building, or to construct a second vehicle.

ESA has not yet officially heard from NASA that there is no hope of the US agency providing the second craft. In what looks like a show of discourtesy on the part of NASA, European officials learned about the administration's decision by reading the newspapers. ☐

NASA's engineers face yet more nights on the tiles

A FUEL SPILL has delayed the second launch of the space shuttle Columbia until the end of this month and possibly longer. Technicians at the Kennedy Space Center are working round the clock to repair the damage caused on 22 September when about 12 litres of toxic fuel spilled from a defective valve. But NASA is still not sure whether it can repair all the damage without rolling Columbia back into its hangar.

The fuel (technically, the oxidiser, nitrogen tetroxide) loosened 338 heat shield tiles by dissolving the glue that holds them to Columbia's aluminium skin. It also seeped into a control module that houses 14 primary and two secondary steering thrusters, soaking insulation blankets and wire bundles inside. The launch directorate at Kennedy first considered taking Columbia down from the pad and rolling it back to the hangar to remove the module for decontamination and to replace the tiles. After a round of conferences with other NASA centres, however, the directorate decided to make the repair with Columbia sitting on the launch pad. A "rollback" would have delayed the flight by six to eight weeks. NASA has already postponed the flight from 30 September to 9 October. The fact that nine years ago a similar spill made it necessary to take Apollo 16 down from its launch pad made engineers believe a rollback would be necessary. And while it was considered feasible to replace tiles on the launch pad, the crew was not sure that it could remove the module, called the forward reaction control system module, with Columbia standing on its tail. But if they manage the job, it will be a step forward in learning how to use the shuttle again and again.

Richard S. Lewis, Florida

NASA crews are now working round the clock setting up scaffolding for replacing the tiles. The original tiles are cleaned and rebonded inside a shelter erected on the scaffolding. Meanwhile, another crew is taking the affected parts down to the hangar for decontamination, and hopes to return them to the launch complex for replacement in about two weeks.

While this is being done, technicians are repairing a leak in the helium tank that serves the affected module. Helium gas pressure forces the oxidiser and the hydrazine fuel into the combustion chamber in the thrusters where they ignite on contact.

Officials at NASA, preoccupied with the repairs, have not made any decision about the other major problem with Columbia's second flight—the vibration at take-off that threatened the first mission with disaster. A giant water spray has been installed in the launch pad to absorb the blast from the engines for the second flight, but NASA has not decided whether the launch will be smooth enough to risk carrying delicate equipment in the shuttle's cargo bay. ☐

THIS WEEK

British satellite TV starts soon—but you can't watch

Peter Marsh

BRITAIN'S first television satellite service will start later this year—but anyone watching it in the UK will risk a heavy fine. Yet 5 million viewers in Europe (mainly in Finland, Austria, Malta, Belgium and Holland) can tune into the satellite service quite legally.

The anomaly arises because Satellite Television, the London company that will provide the programmes, does not have a Home Office licence to transmit in Britain. However, it does have the agreement of Eutelsat, the body that represents Western Europe's telecommunications authorities, to transmit programmes over the rest of the continent.

The firm will transmit its programmes from a British Telecom antenna to the European Space Agency's experimental OTS satellite in orbit 36 000 kilometres above the Earth. (In this, geostationary, orbit the satellite orbits at the same speed as the Earth rotates and so "hovers" above the same area on the ground.) The satellite will broadcast programmes back to anyone on the ground with a receiving antenna (a dish 3 metres in diameter).

Brian Haynes, a director of Satellite Television, says his company will not encourage people in Britain to flout the law by watching its programmes. "This would mean competing with the BBC and IBA, with whom we want to co-operate. Also, at £5000 to £8000, the ground stations will be too expensive for most individuals."

Cable television companies in mainland Europe will receive the programmes (mainly films and television material that has already been broadcast in Britain) and relay them to their customers' homes via existing telephone networks and microwave links. Eventually, the £10 million project should pay for itself through advertising. Some companies, Schweppes for one, are already thinking about advertising on the new service.

The service will be called simply "Satellite"; this name will flash onto the people's screens at the start of each day's viewing. Initially, programmes will go out for 3 hours a day; later there will be 6 hours of programmes on weekdays and 10 hours at weekends.

"Satellite" will be Western Europe's second direct-broadcasting television service. The first, run by the French national television company, started in December last year. This service, using another set of transponders on the same OTS satellite, broadcasts a compendium of the day's French television programmes to viewers in France and Tunisia. At first, households in other parts of Europe were also tuning in; but the French put a stop to "illicit" viewing by transmitting in a special code that cannot be picked up by television sets outside the two countries.

Meanwhile, plans for Britain's official satellite television service are taking shape. Viewers could be receiving satellite programmes legally by 1986 if the government agrees to a £160 million scheme put forward by British Aerospace, Marconi and British Telecom. The service would use a purpose-built satellite based on satellites British Aerospace is already building for the European Space Agency. The BBC is interested in transmitting a new subscriber-only service via the satellite.

The consortium will probably submit its final specifications to the Home Office in November. Earlier this year, the Home Office cautiously welcomed the idea of direct-broadcasting satellites and asked firms to submit detailed proposals. □

A 3-metre dish is a little large for the front room—and expensive, too

New holdup for Ariane

NASA IS not the only space administration to be worried about whether its next flight will leave on time. Officials at the Paris-based European Space Agency have postponed the launch of the fourth Ariane rocket by a fortnight. Ariane, which is now officially proven with two successful launches behind it, should take off from a launch pad in French Guiana on 14 December.

The rocket is taking into orbit an important payload—the first of two Marecs satellites which will provide worldwide communications for ships. The delay was because engineers had trouble ensuring that equipment on the satellite was compatible with the rocket. According to the agency, the technical problems are now solved and the satellite is about to leave Toulouse for the launch pad.

The European agency will officially own both Marecs satellites. But they will be administered by a London-based organisation called Inmarsat, in which 36 of the world's seafaring nations are shareholders. Inmarsat formally starts operating in February, when it takes over three other satellites for maritime communications which are now run by Comsat of the US. □

The spotlight falls on Langmuir Blodgett films

LANGMUIR BLODGETT films may mean nothing to you now—but they will if a unique initiative taken by the Science and Engineering Research Council works. After surveying research in universities and industry, the council has put Langmuir Blodgett films at the top of its list of scientific topics that have commercial application.

Langmuir Blodgett films are layers of organic material, one molecule thick, gently laid down in a perfectly ordered sheet on a solid base. Scientists can chemically tailor the layer so that its electronic properties are sensitive to light or their chemical environment. Such films are likely to be the basis of new kinds of electronic devices for optical communications and for converting solar energy to electricity.

A working party of scientists from several disciplines, set up under the auspices of the Science and Engineering Research Council, picked Langmuir Blodgett films as the best candidate for a new initiative aimed at developing commercially important science. The council has now established a committee headed by Professor Gareth Roberts of Durham University to recommend how much it should spend on research into Langmuir Blodgett films and where its money—about £50 000—should go.

The committee—of chemists, biologists and physicists (one from industry)—is organising a symposium for next autumn. Some British companies—Plessey, GEC and notably ICI (which did much of the original British work on Langmuir Blodgett films)—are already interested. But so are other countries. American giants such as IBM, Rank Xerox and General Electric already have research programmes on Langmuir Blodgett films; Japan, France and Germany have related programmes.

The Science and Engineering Research Council already runs several "specially promoted programmes", but its initiative on Langmuir Blodgett films will be the first time it has singled out such a closely defined area of science for special treatment. Liaison with the Department of Industry is likely and if the initiative is a success, it could be a precedent for others. So far, the council has not selected other possible projects. □

Lucky dip for the electronic future, p21

Industry lines up to squeeze the oil barrel

AMERICAN oil companies are rushing to spend up to $20 billion on new ways of squeezing more oil out of reservoirs. In Britain, both the Department of Energy and private companies are trying hard to make similar processes, called enhanced oil recovery (EOR), work. But while companies are still trying old ideas such as heating the oil underground with pressurised steam, researchers have started developing new types of bacteria to do the work for them.

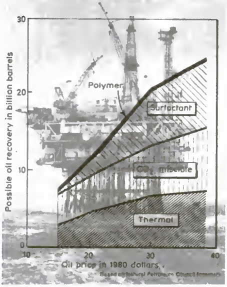
The biggest push toward enhanced recovery has come from the US. The government ran a scheme for a year that allowed oil companies to keep more profits from oil obtained by EOR—as long as they invested some of the cash they saved in the new technologies. The result was 423 proposals for ways of enhancing recovery. The US government is also giving $600 000 to six projects to investigate enhanced recovery using bacteria.

Optimists say that enhanced recovery will recover 10 per cent more oil from existing or abandoned wells. But companies have often been unable to tell whether enhanced recovery is increasing the flow of oil.

Reservoirs are made of dense rock, with oil trapped in tiny pores. In a conventional well, pressurised gas drives out about one third of the oil. The rest sticks in the rock, often in inaccessible crevices. Conventional attempts to flush out the oil may miss it completely, with the engineer on the surface being none the wiser. In some cases oilmen have used EOR for years on end before they can force any more oil out of the ground.

This uncertainty is one reason why scientists are turning to microbes to do the work. For a start, bugs are cheap—once genetic engineers have "built" the right ones. And they are easy to pump into reservoirs along with water. The idea is to develop bugs that feed off the oil. They would then produce wastes similar to the gases, acids and other chemicals that are now pumped down to the oil from the surface. This is not an easy task, as Professor Vivian Moses, a biologist at Queen Mary College, London, told *New Scientist*. In the North Sea bugs would have to survive conditions ranging from freezing seawater to temperatures of 100°C 3000 metres below the seabed. They would have to produce the desired waste product reliably for a long time, and be small enough to move through the porous sandstone in oil reservoirs.

But Moses, who has grants of nearly £200 000 from the Department of Energy, BP and the Science and Engineering Research Council, believes that bacterial enhanced recovery could work within 10 years. The oil industry, although fascinated, remains sceptical. Microbial recovery was not even on the list of subjects for discussion at an international symposium on enhanced recovery held in Britain last week. ☐



Why industry is interested

Residents had complained about explosion tip

A TOXIC waste tip in the middle of a residential area in Stoke-on-Trent was rocked last week by an explosion that blasted a hole more than a metre deep and two metres across. The tip is operated by Cleanaways Ltd, the company that runs the huge Pitsea tip in Essex, which was recently given a clean bill of health by a House of Lords report on the disposal of hazardous waste.

Local residents have been complaining about the tip, in the village of Stonyford, ever since it opened last May. An action group formed to monitor the site has given Staffordshire County Council details of what it claims are infringements of the site's licence.

Cyril Yearsley, divisional officer of the Staffordshire Fire Brigade, told *New Scientist* that the explosion was caused by a 45-gallon drum of magnesium/aluminium turnings that was lying in a pool of battery acid. The Department of the Environment says that "it is not safe to store acids and highly reactive metals together".

Local residents have called in the Ombudsman to investigate charges that the county council ignored warnings that the site was being operated in violation of its licence. The local action group says that the tip accepted concentrations of lead up to 100 times the licensed level and that 45-gallon drums, such as the one involved in the explosion, were dumped in spite of a ban on containers holding more than 5 pints.

The group is also concerned that the site's perimeter fence is only a metre away from the back gardens of homes where young children live. In August they demanded that the tip be closed. ☐

Coal study

SWEDISH scientists are mounting an international research project to find out how much the country's turn to coal for power will damage the health of people near power stations. Sweden relies for its energy on oil, hydroelectric power and nuclear reactors, so, the scientists from the National Institute for Environmental Medicine at the Karolinska Institute had to go to neighbouring Finland to find a coal-fired power station.

The man in charge of the project, Professor Rune Cederhof, sees emissions of sulphur dioxide, soot, oxides of nitrogen, carbon monoxide and cancer-causing hydrocarbons as the main danger. His team will monitor the air around power stations for these substances, examine people living nearby, and send questionnaires to another 15 000 people asking about their health.

The survey will also monitor pollution from an oil-fired power station and question people who live nearby for comparison. ☐

Research rejuvenated

FRANCE'S research and technology minister, Jean Pierre Chevènement, has told the National Science Research Centre that it may recruit five per cent more staff every year to "rejuvenate" the ageing population of French scientists.

Chevènement has also told the centre that its statutes would undergo radical changes, in organisation and personnel. Chevènement wants to increase the number of interdisciplinary research projects.

Meanwhile, the French government is to give a technology development agency, Anvar, 50 per cent more money next year to help form new high-technology businesses. It will have around £70 million to spend in 1982. ☐

Cash for technology

ONE of the worst hit victims of the government's cuts in higher education, Aston University, is linking up with Birmingham City Council to encourage high technology companies to move to the city. The university will manage Birmingham's Science and Technology Centre, and the council is contributing £2·5 million to its costs.

The university says the link with Aston should dramatically reduce the time it takes to turn new ideas into new products, giving firms a lead over their competitors.

In July, the University Grants Committee cut its grant to Aston almost by half over the next three years and told it to reduce the number of students in its engineering and biology departments. Professor Frederick Crawford, vice chancellor, said: "It is particularly reassuring to us . . . that the city to which we are so closely linked, and which understands our strengths, should express its confidence in us by locating the venture adjacent to our campus." ☐

Iranian research gets an Islamic flavour

IRAN'S universities are due to re-open this month after a year's break. But when—and if—students get back to their classes they will find many changes in the courses—especially in science and technology.

Ayatollah Khomeini closed the universities and colleges last year, claiming that: "most of the universities conduct courses that hardly suit our needs. It is better to close them with all their meaningless courses for a year and plan something new and relevant." Now he has pledged that universities which offer "courses indispensable for the country" will re-open, despite the unrest following the recent wave of assassinations and executions.

The new courses are the work of *Jihad-e-Daneshgahi* (University Jihad), a seven-member council that has mobilised some 3000 academics to translate and write 2000 books for the new courses. The council claims to have made "basic changes in the university system" and to have created an educational system that reflects Iran's needs and an Islamic outlook.

The council drew up new research programmes for some 18 universities, but so far the Council on the Cultural Revolution—the body that has overall responsibility for education — has approved only two. There is some confusion about the legal status of University Jihad—universities are not sure whether they are bound to adopt the new programmes or whether parliament has to approve them first.

But the emphasis of the new curricula is already clear. They will concentrate on practical research and developing indigenous industrial skills. They give priority to universities with a strong technical and medical bias: Tehran University has started work on a new way of making insulin and an industrial process for synthesising vitamin B. The university's pharmacists are also synthesising dapsone, the most common drug used against leprosy, still a major problem in Iran.

Ziauddin Sardar

The universities' manufacturing activities are designed to meet local needs and to develop much-needed support for Iran's industries. For instance three engineers working for the Iranian Centre for Scientific and Industrial Research have designed and built a chicken incubator with a capacity of 120 000 eggs. The designers, Hassan Mohajer, Hossein Mire-Azfal and Behruz Faridi, say the incubator is better than foreign imports because it is easier for villagers to understand.

These innovations are a product of the *Jihad sa Zindigi* (fight for reconstruction)—a programme that aims to take science to the country's villages. Scientists and engineers working for the programme travel to provinces to study what the villages need, then a specialist team which might include doctors, agronomists, hydraulic engineers and builders, goes to the village. This team works with the villagers to build houses, dig wells, build schools and clinics, tackle farmers' problems with locally-available resources, and generally make the village as self-sufficient as possible.

Iranian engineers working in the villages have to rely on ingenuity and innovation rather than outside help to solve their immediate problems, which spurs many new inventions. The centre plans to publish its own technical and industrial journals to spread the ideas. The first of these journals, *Iranian Metallurgy*, will appear this winter according to the centre. ☐

Popperfoto

Iran's leaders want to channel their students' energy into the villages

Electronic breath-testers are a sobering experience

POLICE in Brighton, Bexleyheath and 10 other towns all over Britain will be asking drunken drivers to do some extra heavy breathing over the next three months. They will be trying out three new electronic breath testers that could replace tests on blood and urine as evidence that drivers have had too much to drink.

If the trials are successful, motorists who fail a conventional breath test will have to blow into an electronic box—and the driving drunk's dreaded figure will be 35 microgrammes of alcohol per 100 millilitres of breath instead of the present limit of 80 milligrammes of alcohol per 100 millilitres of blood. (Motorists near the limit will still have the right to insist on a blood test.)

The Home Office presented its new machines to the press last week. They are distinctly unprepossessing for devices with such awesome power—simply a metal box with a tube to blow in (or possibly two boxes depending on how much you've had to drink). The Home Office says the public have cooperated enthusiastically with previous trials of electronic testers. One man who had the equivalent of 300 mg per 100 ml apparently told police: "Let me do it again, I can go higher than that."

The purpose of the machine is to give motorists an instant result, instead of keeping them waiting for up to a month to learn whether they have committed a crime. In pursuit of this worthy objective, the Home Office will buy 800 of whichever breathalyser passes the test—at £2000 each.

Unfortunately, spending cuts seem to have severely affected the Home Office's hospitality. Although the machines were on show at the crack of noon, the Home Office failed to provide any wherewithal for the thirsty hacks to try them out. There was nothing but coffee (in Thermos flasks with powdered near-whitener)—and that ran out.

Amazingly only one hack had nerved himself for the press conference—with a single gin. He marked up 5 mg of alcohol—well within the limit. No-one else managed to move the machine at all, although the BBC's representative almost passed out. Bending down to table height to blow into a tube is difficult enough when you're sober, she said.

Mick Hamer

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On the edge of the atmosphere, space shuttle Columbia was about to lose all contact with Earth: for 21 agonising minutes, touch-down would be touch-and-go.
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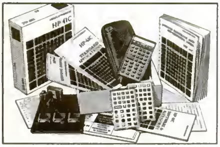

The HP-41C hand-held 'computer' in a box. £165 brings you the calculator, a comprehensive 270-page manual, owner's handbook, and programming guide, a standard applications handbook, customising overlays, HP Users' Library membership reply card, free one year's subscription to HP's User's Newsletter, batteries, carrying pouch and 12 months' full guarantee.

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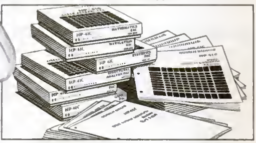

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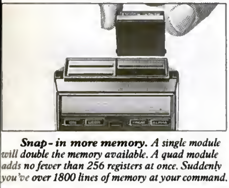

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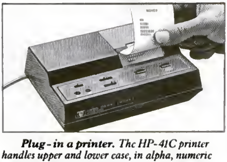

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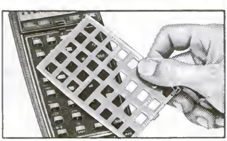

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THE FUTURE IN SPACE

America's space shuttle should soon take off for the second time and we will begin to find out if the age of the space commuter has truly begun. With the reusable shuttle, a space journey that involves the destruction of virtually all the vehicle will seem as ridiculous as a transatlantic flight in which, at the end, the aircraft is consigned to the rubbish heap.

But for all the brouhaha surrounding the shuttle, in recent years the American space effort has been eclipsed by the Soviet Union. The USSR not only puts people into space; it keeps them there for long periods aboard orbiting stations. And quite conceivably (the evidence is not on show for us to say definitely) the country has advanced considerably in space science—for instance in finding out how to make new materials in zero gravity. Unhappily, scientific research plays only a minor role in America's space plans; and it could diminish still further with fresh public spending cuts still to come.

Yet it is in the area of science and technology that space perhaps has most to offer. The world has already seen some of the benefits of space research—in weather forecasting, communications and in understanding the Solar System. The next two decades could bring a new order of exploitation: permanent factories in the sky or on the Moon, and ways of tapping the solar energy that at present radiates uselessly into space.

The biggest uncertainty is whether the world can cooperate in exploiting the vast resources beyond the Earth's atmosphere. As James Oberg of NASA points out (p 17) the time is now right—from a technological point of view—for the US and the USSR to cooperate, instead of producing an ever more fearsome range of space weaponry. This kind of collaboration must take place if mankind is to have a future in space.

America's rookie astronauts

The second flight of the space shuttle has been postponed again; it should take place later this month. But delays are nothing new for America's small army of astronauts—some have been waiting 15 years for their first trip out of the Earth's atmosphere

Peter Marsh

The US has 81 astronauts in training. They go to classes, fly aeroplanes and do exercises. Between them they have made only 13 space flights—and many have been on standby for well over a decade. "In this business," says rookie astronaut Jeff Hoffman, "you've got to learn to wait."

Just 9 of the 73 men and 8 women have been into space. And of their meagre total of 13 space flights, 5 were made by one person—veteran spaceman John Young, the space shuttle's commander during its first voyage in April. The record looks paltry indeed compared with the 73 journeys above the Earth's atmosphere made by Americans since Alan Shepard went on the nation's first space excursion in 1961. And it looks even more meagre compared with the Russian efforts in space over the past few years (Box A).

The astronauts are waiting for one thing—a chance to fly on the shuttle once it is proven. Following the second flight, NASA plans two more test launches. Then the forays into the heavens start to build up: seven are planned for 1983, nine in 1984, leading to 19 in 1986 and perhaps 50 per year thereafter. By then four shuttle vehicles should be operating (including the present one).

Some of the astronauts have been on the sidelines for a long time. The biggest sufferers are Don Lind, aged 50, and 41-year-old Brice McCandless. Both joined NASA in 1966 and have yet to make their first flight. Relief is at hand, however, for Joe Engle, aged 49, who started his astronaut's career in the same year.

Engle has a colourful background. A fighter pilot in the Second World War, he has logged 10 000 hours' flying, counts big-game hunting among his hobbies and (possibly to his embarrassment) was voted one of the Ten Outstanding Young Men in America in 1964. Yet the nearest he has come to a space flight was when he was a back-up pilot for an Apollo Moon-landing back in 1971.

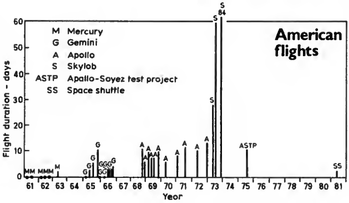
Engle should finally get into orbit this month aboard the shuttle—in company with 43-year-old Richard Truly, a former navy pilot, who has had to wait a mere 12 years for his big moment.

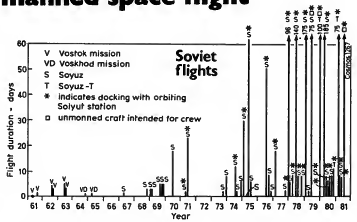
The more impatient astronauts include a clutch of seven who signed up in 1967. Joseph Allen, Anthony England, Story Musgrave, William Lenoir, Karl Henize, William Thornton and Robert Parker—not surprisingly, their names mean nothing to most people as none of the group has yet ventured into orbit. Of the seven only Parker has been told when he will fly, in 1983. The others will have to gnaw their fingernails like the rest of NASA's astronauts.

When they joined, the seven budding space travellers

The original seven Mercury astronauts: (from left) Cooper, Grissom, Carpenter, Schirra, Slayton, Shepard and Glenn

A. Two decades of manned space flight





Above: how the USSR has forged ahead of the Americans in manned space missions. Left and right: the records of the 103 people who have been into orbit—the rockets represent the number of individual space flights

🚀🚀🚀🚀🚀 John Young *(M)

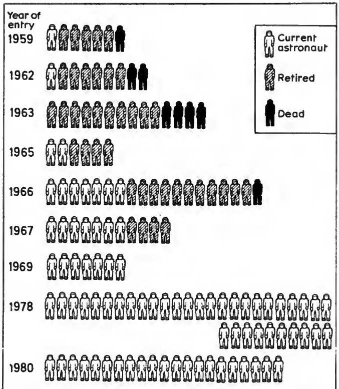
🚀🚀🚀🚀 Thomas Stafford, Charles Conrad (M), James Lovell.

🚀🚀🚀 Eugene Cernan (M), David Scott (M), Wally Schirra.

🚀🚀 Edwin Aldrin (M), Neil Armstrong (M), Alan Bean (M), Frank Borman, Michael Collins, Gordon Cooper, Richard Gordon, Gus Grissom, Alan Shepard (M), James McDivitt.

🚀 Deke Slayton*, Bob Crippen*, Owen Garriot*, Joseph Kerwin*, Vance Brand*, Jack Lousma*, Paul Weitz*, Thomas Mattingly*, William Anders, Scott Carpenter, Gerald Carr, Walter Cunningham, Charles Duke (M), Donn Eisele, Ronald Evans, Edward Gibson, John Glenn, Fred Haise, James Irwin (M), Edgar Mitchell (M), William Pogue, Stuart Roosa, Harrison Schmitt (M), Russell Schweickart, John Swigert, Edward White, Alfred Worden.

Key: * Astronaut still with NASA; (M) Walked on Moon surface



Virtually all the astronauts that NASA hired at the start of the space race have now left; of the 1959 and 1962 intake, only Deke Slayton and John Young are still with NASA

🚀🚀🚀🚀 Oleg Makarov

🚀🚀🚀 Vladimir Shatalov, Alexei Yeliseyev, Valeri Bykovsky, Valeri Kubasov, Nikolai Rukavishnikov, Viktor Gorbatko, Valeri Ryumin, Pyotr Klimuk.
Vladimir Kovalenok.

🚀🚀 Georgi Grechko, Vitali Sevastyanov, Boris Volynov, Alexei Gubarev, Vladislav Volkov, Andrian Nikolayev, Pavel Popovich, Anatoli Filipchenko, Alexei Leonov, Vladimir Komarov, Vasily Lazerev, Leonid Popov, Vladimir Dzhanibekov, Yuri Romanenko.

🚀 Alexander Ivanchenkov, Vladmir Lyakhov, Yuri Malyshev, Vladimir Aksyonov, Gennady Strekalov, Victor Savinykh, Vitaly Zholobov, Georgy Dobrovolsky, Viktor Patseyev, Yuri Artyukhin, Yuri Glazkov, Vladimir Aksenov, Valentin Lebedev, Gennady Sarafanov, Lev Demin, Georgi Shonin, Vyacheslav Zudov, Georgi Beregovoy, Valeri Rozhdestvensky, Valentina Tereshkova, Yevgeny Khrunov, Pavel Belyayev, Konstantin Feoktistov, Herman Titov, Yuri Gagarin, Boris Yegorov. Vladimir Remek (Czechoslovakia), Miroslaw Hermaszewski (Poland), Sigmund Jaehn (East Germany), Georgi Ivanov (Bulgaria), Bertalan Farkas (Hungary), Pham Tuan (Vietnam), Arnaldo Tamayo Mendez (Cuba), Jugderdemidiin Gurragcha (Mongolia), Dumitru Prunariu (Romania).

	Manned missions	Astronaut flights	No of astronauts in space	Moon landings	Visits to space stations	Total flight time (man-days)
USSR	49	94	59	0	3	2124
US	32	73	44	6	18	942

must have thought their prospects were rosy. NASA's space programme was moving at an astonishing pace. A series of 10 two-man Gemini flights had just finished, the launches occurring at the rate of one every six weeks. With the Apollo programme just about to start, putting the first man on the Moon within two years, the US was spending billions of dollars on cannoning people out of the Earth's atmosphere. Little did the hopefuls realise that after the final Moon landing in 1972, trips away from the Earth would all but dry up.

Since then, NASA has been able to offer its employees places on just five voyages into outer space—three missions to the orbiting Skylab in 1973, a joint flight with two Russian cosmonauts two years later . . . followed by a big gap until the maiden shuttle launch earlier this year. If the job of an astronaut (even a ground-based astronaut) were not so prestigious, the disappointed seven might have sued their employer for giving a misleading job description.

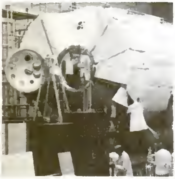
The present frustration results from the technical delays in getting the shuttle airborne. According to NASA's 1978 timetable, the craft should have made its first flight in June 1979: by the beginning of next month, the craft would have flown in space not twice but 20 times. This schedule would have given flight experience to perhaps 40 of the astronauts who are still looking forward to their first voyages into weightlessness.

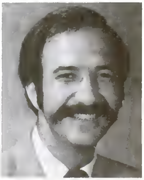
Over the years, however, surprisingly few astronauts have left NASA before getting a chance to fly. Of the 129 people who have been astronauts since NASA created such posts in 1959, only seven have quit without a spaceflight to their name—and one of these, John Bull, left because he was ill. (Six more have been killed while still in the novice category.) John Llewellyn, the only Briton ever to have been an astronaut, resigned for personal reasons in 1967 after just one year. Duane Graveline, a doctor, and Brian O'Leary, a physicist, lasted for even less time before leaving in 1965 and 1968 to return to their previous careers. Of the others who have left voluntarily without going up in space, the record for flightless tenure is held by Philip Chapman who was an astronaut for five years before taking up a research job with the Massachusetts Institute of Technology (MIT) in 1972. "If I'd been waiting since the mid-1960s for a flight, I think I would have left by now," says Frank Hughes, who, as one of the chief training officers at the Johnson Space Center, has been observing astronauts for 15 years. "But there are a lot of plusses that go with the job."

Indeed, 13 000 people applied for the post on the last two occasions that NASA advertised it. The administration finally took on 56 who started their training in two batches, in 1978 and 1980. The members of this group (all of whom have yet to fly in space) are the real rookies of the space corps.

The astronauts share offices, two or three to a room, on the top floor of an ordinary-looking, three-storey building at the Houston centre. The centre itself comprises low, white buildings separated by expanses of pleasant greenery. It could be confused with a university campus—which is appropriate, as the astronauts are, for much of the time, students. They receive lessons on engineering (how the shuttle works for instance), learn to fly jets (if they know already, they practise), keep fit and work on specific engineering tasks, for instance the design of space suits or experiments that will be done on board a future shuttle. The astronauts meet every Monday morning to compare notes: they spend much of the rest of the time in groups, headed by senior members of the fraternity. Among the latter are John Young, formally titled the Chief of the Astronaut Office, with a record five space flights to

B. Spacelab — an expensive way to get into orbit





Spacelab represents the only chance in the forseeable future for Western Europe to claim the kudos of putting a man into space. This person would join the select list of 103 people who have travelled beyond the Earth's atmosphere.

A big aluminium cylinder which can be put in series with a combination of unenclosed pallets which will be laden with equipment, Spacelab will orbit the Earth for a week at a time on board a space shuttle. The European Space Agency is building two of the modules, which can each carry several people and has room for dozens of scientific experiments. Both will become the property of NASA; in exchange, the 11-nation European agency will receive £90 million (a small sum considering that Spacelab cost £400 million to develop) plus the chance to participate as a joint partner in the first Spacelab mission in 1983.

One Western European is sure to go into space on this trip, to look after the experiments. The other five crew members will be American.

West Germany has scheduled another Spacelab mission in 1984, which, initially, it intended to pay for by itself. But the escalating costs have surprised West German government officials, who are already aggrieved that their country has footed the bill for half the Spacelab development work with, so far, little to show for it. The officials calculate that the week-long mission will cost £60 million; of this NASA pockets some £20 million for launching the craft and the rest is eaten up in testing, data processing and so on. "We had not thought it would be so expensive," admitted one civil servant ruefully.

Training is hair-raising for Claude Nicollier, a European astronaut, who, with Wubbo Ockels of Holland (above, right) hopes to go into orbit in Spacelab. Above, left: the laboratory under construction in West Germany and how it will fit into the shuttle

Thereafter, the future for European manned efforts in space looks cloudy. The Paris-based officials of the European agency want more Spacelab flights; but, specially in the light of the costs of the German mission, they are having problems convincing the agency's member nations to foot the bill.

NASA is preparing a scale of charges for Spacelab flights which should be ready next year. In theory, it will take into space any suitable experiment for a fee depending on the weight and size of the equipment. So far, NASA is preparing to fund just three Spacelab flights —the joint venture with the European agency, plus two others in 1984 and 1985 which will concentrate on experiments in astrophysics, life sciences and materials processing.

Here's hoping they'll get into space: from left, Joe Engle and Dick Truly, Steven Hawley (at 29, the youngest astronaut) and Anna Fisher in official NASA garb

his name; Owen Garriot and Jack Lousma, who both clocked up 56 million km of space travel during a 59-day Skylab mission; and Deke Slayton, the only member still with NASA of the seven original Mercury astronauts selected in 1959.

Times have changed since those heady days. The "Mercury seven"—they formed the crew for the six one-man flights between 1961 and 1963 that started America's manned space programme—were fêted as heroes. The newspapers heralded them as bold warriors who, at the height of the Cold War, were fighting the USSR for supremacy in space. It was about the time of Lyndon Johnson's famous remark that he wouldn't much fancy staring up at the Moon at night and seeing a Russian flag on it.

Not surprisingly, the Mercury men became a little arrogant. "In the old days the astronauts were worshipped," said one NASA engineer at Houston. "The present bunch are much nicer, more convivial. They realise they're part of a team."

Yet the current stock of astronauts is hardly starved of publicity. NASA employs five people just to book up engagements and write speeches for them. Although they are asked to make more, each astronaut is limited to six public appearances per year; more than this would interfere with their work. Much attention focuses on the eight female astronauts: Bonnie Dunbar, Mary Cleave, Anna Fisher, Shannon Lucid, Judith Resnik, Sally Ride, Margaret Seddon and Kathryn Sullivan. All are attempting to become the second woman in space, the first since Valentina Tereshkova circled the Earth 48 times in June 1963.

The aspiring spacemen and -women are divided into two categories—experienced jet pilots, who will be primarily responsible for flying the shuttle, and scientist-astronauts, who NASA now calls "mission specialists". These people, who have scientific backgrounds, will supervise engineering equipment on the craft, release into space payloads such as satellites and do odd jobs, for instance venturing outside to repair bits of the shuttle that go wrong. By the late 1980s, each pilot can expect four shuttle flights per year; mission specialists will do well to get one.

NASA enrolled its first six scientist-astronauts in 1965, but until recently the pilots heavily outnumbered them among the astronaut corps. In the past three years, the administration's recruiting officers have more than redressed the balance. The astronauts now comprise 38 pilots and 43 mission specialists. Only pilots—two for each flight —will ride in the space shuttle for the first five launches. The first mission specialist will get his (or her) chance in December 1982. Thereafter crews will number up to six, of which two will be pilots and the rest divided between mission specialists and what NASA calls "payload specialists"—ordinary scientists who merely supervise experiments and receive virtually no flight training.

The minimum qualification for pilot-astronauts is straightforward enough. Candidates must have flown for 2000 hours in jet aircraft and be physically fit. To be a mission specialist, a rather more subtle blend of qualities is required. You need relevant scientific expertise—such as a degree in physics, astronomy or geology—an ability to work in a team and, perhaps above all, a willingness to learn about several disciplines and become a scientific all-rounder. This broad outlook is reflected in the backgrounds of some of the mission specialists.

Karl Henize, one of the aspiring spacemen, is an astronomer with 56 scientific publications to his name: he has also found time to log 1900 hours of jet flying. William Lenoir has worked on the design of a solar-power satellite; Story Musgrave is a free-fall parachutist who works part-time as a surgeon at Denver General Hospital; Bonnie Dunbar is a ceramic engineer who worked for Rockwell on the shuttle's heat-resistant tiles before joining NASA last year. Of the others, Judith Resnik has been a missile engineer, neurophysiologist and classical pianist, while the soccer-playing Franklin Chang worked on America's fusion energy programme and for 2½ years ran a community residence for mental patients.

Claude Nicollier, another of the astronauts, is sad that because of his job he cannot study his chosen discipline—astronomy—as closely as he would like. "There's no doubt that to cope with the vehicle [the shuttle] you can't do so much scientific research. So I don't publish any more. Instead we have to be trained in other disciplines—we have to be the brains and hands of the scientists on the ground."

But Nicollier, who is Swiss, hardly minds doing varied jobs. Straight after three years as a researcher at Geneva Observatory, he became an airline pilot for Swissair in 1974. Wishing to change direction once more, he quit in 1976 to work in astrophysics at the European Space Agency's scientific laboratory in Holland.

It is ESA—the European Space Agency—not NASA, that formally employs Nicollier, and another of the astronauts training in the US, Wubbo Ockels of Holland. The pair may become mission specialists on future shuttle flights. But their main job is to train for the first Spacelab mission in 1983—which NASA and the European agency are jointly organising. Spacelab is an European-built canister of experiments, with room for several people, that the shuttle will take into orbit for a week at a time. Either Nicollier, Ockels or a third ESA astronaut,

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Ulf Merbold of West Germany, is to get one of the jobs of payload specialist on this flight. The other five members of the crew will be American.

Ockels, a nuclear physicist, says the position of science in the American space programme is "rather weak". Many scientific experiments have been cut from the shuttle's flight schedule. Even the future of Spacelab is doubtful after the first four flights. Neither NASA nor the European countries that have built the laboratory have yet committed themselves to financing further launches (Box B).

Jeff Hoffman, one of the American astronauts and a former MIT astrophysicist, shares the unease. "I feel disappointed that in the next few years the shuttle programme will not involve much of a role for science."

Other people in the Johnson Space Center are worried about the shuttle. But, paradoxically, their fears concern what will happen if the vessel becomes a success too quickly. Frank Hughes, one of NASA's instructors, says he is "terror-stricken" that he will not be able to train shuttle pilots fast enough if NASA's proposed schedule of one flight per week becomes a reality. The problem concerns the two shuttle simulators. These are life-size mock-ups of the shuttle cockpit, each costing (at today's prices) about £40 million and controlled by a roomful of computers to make them behave like the space plane in flight. Shepherded by a team of 70 instructors, NASA pilots practise for 1000 hours in a simulator before they take the real thing into space. Hughes says that unless NASA buys more simulators, future pilots will have to go into space less well trained: with the current hardware, there simply will not be time to instruct them.

NASA wants more work for computers

One way out of the impasse is to train the pilots to do less during a flight; this means giving more work to the craft's computer-controlled equipment which (in theory) can fly the vessel automatically. The trouble is that the engineers do not quite trust the computers to do their jobs. The flight routine gives pilots the opportunity to take over the controls at the slightest hint that anything has gone wrong. "Once we have confidence in the system we will be able to give it more work," says Hughes.

The plans for next two shuttle launches indicate a gradual change in attitude. To return the craft to the Earth after its first launch in April, John Young, the craft's commander, steered it manually to the landing site from an altitude of 15 000 metres. On the second flight, Joe Engle will take over from the computers just 8000 metres above the Earth. And during the landing procedure for the shuttle's third flight in January, Jack Lousma and Charles Fullerton, commander and co-pilot respectively, will do virtually nothing while the craft lands itself.

How difficult is the shuttle to fly? Hughes says that if flying a Boeing 727 airliner requires a skill level of 1 or 2 on a scale of 10, then piloting the shuttle equates with a point on the scale around 9. And Dick Richards, a 34-year-old navy pilot who became an astronaut last year, says the shuttle is "magnitudes" more complex than steering what he is more used to—an F-18 fighter jet which incorporates the latest avionics technology and is still to come into regular service. "You fly the F-18 for no more than two hours; if something goes wrong then the situation is not too difficult. On the shuttle you might be in flight for a week. And there are 1700 switches to throw, compared with 30 to 40 on the F-18."

Richards is resigned to waiting until 1985 for his first shuttle flight: he knows that the more experienced pilots will get their chance first. But he gives little indication that the wait will not be worthwhile. He, like the other astronauts, would probably agree with the sentiments of Claude Nicollier: "If I could fly in the shuttle just once, then it would be worth 10 years of my life." □

The Soviet aim: a permanent base in space

A mysterious Russian craft called Cosmos-1267 is circling the Earth, docked to the Salyut-6 space station. It may signal that the USSR is near to realising its ambition of keeping at least one person in orbit all the time

James Oberg A new phase of space exploration is about to begin, probably next year. The Soviet Union seems likely to put into orbit a space station that will be permanently manned, with crews replacing each other by rota. From this point, there will never again be a moment when at least one human being is *not* in space.

The launch of the new space station, dubbed "Salyut-7" after the six previous stations in the Salyut series, will be the latest in a sequence of impressive Soviet achievements in putting people into space. Whereas the US has concentrated on devising a reusable craft that can carry as much as 30 tonnes at a time into low-Earth orbit (200-300 km high), the Soviets have aimed at taking smaller loads into roughly the same orbit—and then joining them to make large stations in which people can live. In the past four years, the USSR has shown that people can exist for long periods in space, establishing manned missions that lasted for periods of 96, 140, 175 and 185 days. (The previous record for endurance in space was held by one of the 1973-74 Skylab crews of the US, which lasted 84 days.)

Associated Press

Alexei Gubarev (top) and Vladimir Remek say farewell before one of the first missions to the Salyut-6 space station in 1978

These missions have all centred on Salyut-6, a 19-tonne station launched in September 1977. Crews have travelled to the station in Soyuz "space ferries" which can dock at one of two entry ports on the station, giving a total mass in space (when two Soyuz craft are docked simultaneously) of some 31 tonnes. Long sojourns in space have been made possible by visits to the station of unmanned Progress supply ships which can carry up to 2·3 tonnes of cargo, such as food and equipment.

During its four years in space, Salyut-6 has hosted six main manned expeditions (totalling 23 months of occupation) and 10 short visits of a week or so. It has also docked 13 times with unmanned supply ships sent up from Earth.

On 19 June, the Soviets tried something different when they sent to Salyut a big, new craft called Cosmos-1267. Unmanned, this had a mass (at docking) of some 10 to 15 tonnes, twice as much as a Soyuz craft. When joined to Salyut, this provided a total mass in orbit of about 35 tonnes. It seems likely that the docking of Cosmos-1267 (which, mysteriously, had orbited "solo" for eight weeks before approaching the station) will be the first stage in Soviet plans for constructing large space stations from separate modules. Three months ago, during ceremonies at the Kremlin in honour of the latest (and probably last) group of Salyut-6 cosmonauts, Soviet leader Leonid Brezhnev announced to the world that "we are ready to make the next step—to graduate to the creation of permanent orbital complexes."

The Soviets are forced to make their space stations out of small units which are taken into space separately as, by American standards, their rockets are rather feeble. The heaviest payload ever lifted successfully by a Soviet booster weighed a little more than 20 tonnes, a fifth of the comparable figure for American rockets. (The US's one and only space station—Skylab—weighed 77 tonnes.)

But the modular nature of the Russian stations may also help the Soviet Union to achieve what appears to be its long-term aim of building up a series of science-based space industries—materials processing for instance. Space engineer Sergey Grishin said in mid-1979: "Orbiting stations of future generations will consist of separate independently-launched modules. The main module will offer more comfortable conditions for crews. Other modules will contain scientific apparatus and technological equipment." Grishin later described these as "individual scientific modules outfitted with instruments and equipment of a certain type."

Over the next few months, a party of cosmonauts may well visit the orbiting Salyut-6/Cosmos-1267 complex to inspect equipment. But, this apart, Salyut-6 is almost certainly about to be "retired". It will stay in orbit, crewless, until it eventually breaks up.

An expected feature of the next station, Salyut-7, is that crews will work only short spells. Cosmonauts will be sent into orbit aboard Soyuz spacecraft, perhaps at the rate of one new crew per month, with the old crew returning to Earth on another Soyuz. This marks a break in the previous pattern. With Salyut-6, a main crew arrived at an empty station, made it ready for habitation (the Soviets call the process "de-mothballing"), hosted several visits from other cosmonauts as well as supply ships and then returned to Earth, leaving the station empty.

Cosmonauts aboard Salyut-7 will, in general, spend less time in space than their colleagues on Salyut-6. A few months ago, space official Vladlen Vereshchetin said the Russians do not plan to better the 185-day space endurance record set up last year. Valery Ryumin, the flight engineer on that mission, elaborated at a press conference in April when he was asked about the possibilities of year-long space odysseys: "After the first and second long flights, I said at conferences that man could work even longer in space. This is actually so—but all the same, after three or four months at work in orbit, exhaustion sets in. Thus if there is not a special need for some sort of very important task, it makes no particular sense to push a cosmonaut's organism to its endurance."

Salyut-7 is the next logical step in a project that started

James Oberg works at NASA's Johnson Space Center in Houston and is the author of *Red Star in Space* (Harrap).

with Salyut-1 10 years ago. The programme's name was connected with a "salute" to the tenth anniversary of Yuri Gagarin's epoch-making space flight—the first time a human being had ventured outside the Earth's atmosphere. The first Salyut mission, in June 1971, ended in disaster. Three cosmonauts who stayed in the station for 21 days perished due to a fault in their landing module just before they returned to Earth. Three later stations in 1972-1973 all failed, before cosmonauts could be launched to visit them. But in 1974 a series of successful, and ever more ambitious, Salyut missions began, culminating in Salyut-6.

Home is a metal canister in space

On board this station, composed of a series of cylinders 15 m long, pairs of cosmonauts stayed healthy, happy and efficient while conducting extensive experiments. As well as determining the ways in which long space flights affect the human body, the cosmonauts took small animals, tissue cultures and plants into space, to investigate how living things grow in zero gravity. The crews recorded gamma rays and made astronomical observations with a sophisticated infrared telescope-camera. They tried making materials such as semiconductors, alloys, and various types of glass; and took shots of the Earth with a powerful East German multi-spectral camera, supplemented by a mapping camera and a battery of hand-held instruments.

The Salyut-6 mission also tested several important innovations in space technology. The station had two docking posts (previous stations had only one). Cosmonauts tried out a new spacesuit that let them venture outside to make repairs, and they experimented with an unfurlable 10-metre radio-dish antenna, which could be a forerunner of large structures that can be assembled in space.

Also tried out successfully was a new manned spaceship called the Soyuz-T, the T standing for "transport". The ship can carry three cosmonauts, or two men and a supply cannister. Compared with the old two-man Soyuz ships which, after a period of "running-in", it replaced in mid-1981, it contains a wide range of improved electronics, propulsion, life-support and power systems.

Salyut-6 still has a few limitations, however. It can carry only 1·5 tonnes of scientific equipment, and of this less than a tenth can be replaced during a mission. Little electric power is available. The 4000 W has to be spread frugally between the "housekeeping" equipment needed to keep the station ticking over; only occasional spurts of electricity are available to power equipment that needs a lot of energy—the telescope refrigeration unit and the furnaces, for instance.

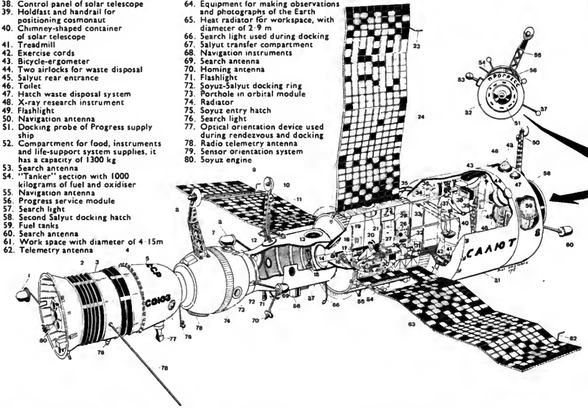
The Salyut-6 cosmonauts had to spend so much time maintaining the station and their own health that they could barely afford to work more than four to five hours per day. The US astronauts on Skylab managed almost three times as much. Again, only a few hundred kilograms of material (film, logbooks, samples, magnetic tapes, equipment and so on) can be brought back from orbit.

The new class of space hardware represented by Cosmos-1267 should improve matters. According to the Tass news agency, the vehicle is designed "to test systems and elements of the design of future spacecraft"—and "methods of assembly of orbital complexes of a large size and weight" were tried out during the linkup. Ex-cosmonaut Konstantin Feoktistov, a leading engineer in the Salyut programme, said that Cosmos-1267 is "a prototype of multi-modular space stations".

But there are several mysteries over Cosmos-1267. The Soviets broke with their tight-lipped news standards and disclosed that the craft had been launched by a Proton rocket, which can put into orbit more than 20 tonnes. Yet depending on which Soviet account is to be believed, the Cosmos-1267 at docking weighed either "more than 10 tonnes" (*Socialist Industry's* space correspondent) or "more than twice the weight of a Soyuz" (that is, more than 15 tonnes, according to Radio Moscow). These descriptions, therefore, pinpoint a "missing mass" of between five and ten tonnes which was lost between the launch and docking.

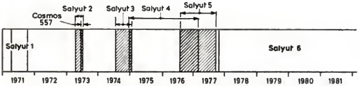
American intelligence experts have worked out where the mass went. After 30 days of solo flight, Cosmos-1267

1. Search antenna
2. Heat radiator
3. Soyuz service module
4. Ring-shaped telemetry antenna
5. Command capsule
6. Navigation antenna
7. Porthole in Soyuz orbital module
8. Salyut search antenna
9. Telemetry antenna
10. Navigation antenna
11. First solar cell panel. It can turn 360°
12. Salyut EVA hatch
13. Large porthole
14. Vacuum cleaner
15. Instrument panel in Salyut transfer compartment
16. Central instrument and control panels
17. Control panel for life support systems
18. Hatch between transfer and work compartments
19. Handrail
20. Commander
21. Electric motor. It rotates solar panels so they always receive maximum solar radiation
22. Two moveable spotlights
23. Telemetry anetnna
24. Second solar panel
25. Handrail
26. Control panel
27. Pantry, with heater for food and first aid kit
28. Table with flap seats
29. Container with hot and cold water
30. Second seat
31. Rotating chair for medical examination
32. Grating of ventilation system
33. Refrigerator
34. Container with biological experiments
35. Handrail for EVA
36. Bed. Second one is on opposite wall
37. Cosmonaut-scientist
38. Control panel of solar telescope
39. Holdfast and handrail for positioning cosmonaut
40. Chimney-shaped container of solar telescope
41. Treadmill
42. Exercise cords
43. Bicycle-ergometer
44. Two airlocks for waste disposal
45. Salyut rear entrance
46. Toilet
47. Hatch waste disposal system
48. X-ray research instrument
49. Flashlight
50. Navigation antenna
51. Docking probe of Progress supply ship
52. Compartment for food, instruments and life-support system supplies, it has a capacity of 1300 kg
53. Search antenna
54. "Tanker" section with 1000 kilograms of fuel and oxidiser
55. Navigation antenna
56. Progress service module
57. Search light
58. Second Salyut docking hatch
59. Fuel tanks
60. Search antenna
61. Work space with diameter of 4·15m
62. Telemetry antenna
63. Third solar panel
64. Equipment for making observations and photographs of the Earth
65. Heat radiator for workspace, with diameter of 2·9 m
66. Search light used during docking
67. Salyut transfer compartment
68. Navigation instruments
69. Search antenna
70. Homing antenna
71. Flashlight
72. Soyuz-Salyut docking ring
73. Porthole in orbital module
74. Radiator
75. Soyuz entry hatch
76. Search light
77. Optical orientation device used during rendezvous and docking
78. Radio telemetry antenna
79. Sensor orientation system
80. Soyuz engine



Anatomy of Salyut-6: the space station that has been home to Russian cosmonauts for up to six months at a time ejected a re-entry vehicle which returned to Earth and was recovered at the Soviet space landing zone in Kazakhstan. The landing craft was significantly larger than the re-entry vehicle on Soyuz craft in which Soviet astronauts return to Earth. These capsules land by parachute, and have retro-rockets which fire a few metres above the ground.

Nor was the Cosmos-1267 mission wholly original. A similar mission took place in 1977 when the Cosmos-929 satellite spent 200 days performing an impressive series of orbital manoeuvres—and, according to intelligence sources, it too dropped off a re-entry vehicle after 30 days. Many features about the satellite were reminiscent of a manned craft.



From hesitant beginnings, the Soviets have kept their Salyut space stations in orbit for increasing periods. (Cosmos 557 was a Salyut variant which failed soon after launch.)

Yuri Gagarin, the first man in space, and (right) a Soviet rocket lifts off from the Baikonur cosmodrome

Although Cosmos-1267 is clearly related to the earlier satellite, it would be a mistake to assume that the two are identical. The four-year gap between them allowed plenty of time for technical improvement. One hint lies in the telemetry signals: according to radio tracker Mark Severance, of the Southern Methodist University in Dallas, "the differences in the two signal formats represent technical improvements in the data interrogation systems or the spacecraft as a whole".

It seems that the Cosmos-1267 module will serve as a vehicle loaded with specialised equipment that can be temporarily attached to a Salyut. Its own solar panels can augment those of the "core" space station. And the satellite's engines can adjust the orbit of the whole complex. This feature would help Soviet space ambitions considerably, as the propellant tanks and engine nozzles of Salyut 6 stopped working after a year or two in space.

And what is the purpose of the unexplained re-entry vehicle? Could it be a forerunner of a Soviet version of the space shuttle? The Russians already have efficient craft for transporting people and cargo into orbit. So it seems that the vehicle will act as a transporter for ferrying equipment back to Earth. Cosmonaut Vladimir Shatalov said this was a problem area back in 1979. He wrote that it is important "to find a way to return a larger amount of scientific data and equipment to Earth from the space station".

The re-entry craft that went into orbit on Cosmos-1267 could have been tested on previous unmanned missions between 1976 and 1979. Then, Proton rockets sent up mysterious payloads which, while in orbit, fired retro-rockets to return them to Earth.

The Russians have said they are considering a shuttle-type craft, but that it is a long way from making an appearance. This is despite persistent reports in American newspapers that the "Soviet shuttle" is almost ready. (The stories may, however, be akin to those of Soviet submarines which are often seen lurking in coastal waters around the time of naval budget hearings.)

Cosmonaut Vitaly Sevastianov gave the official view in April, at the time of the first flight of the US space-shuttle. "We are also thinking—on a long range basis—of a reusable shuttle," he said. "However, at present, detailed calculations confirm that the use of our existing system of transport of persons and cargo, as well as orbital stations of the new generation, will be much cheaper than with a space shuttle, in the next decade at least."

Undoubtedly, the Soviets are developing a small, manned spacecraft that can land on a runway. The vehicle probably does not have wings and would be about a tenth the size of the American shuttles. To call the vehicle a "shuttle" is inappropriate, however. A better comparison is with the US's X-20 spacecraft, called Dyna-Soar, that was cancelled in the 1960s. Like this craft, the Soviet vehicle would be launched by an expendable booster, stay in orbit only a few hours, and would not be reusable.

The US has built its space shuttle because it wants quick, frequent and easy access to near-Earth space; the Soviet Union has set its sights on permanent stations and so favours a different approach. Ironically, the technologies that the two superpowers have chosen are quite complementary: joint US-USSR space efforts have become technically rewarding just at a time when they are not politically feasible. (The two countries have cooperated just once in a big space project: in 1975, crews in Soyuz and Apollo spacecraft docked, shook hands, and then for two days chatted and worked together in space.)

Politics, of course, still has some part to play in space. After its "guest cosmonaut" programme in which pilots from Soviet-bloc nations took it in turns to ride on Soyuz vehicles, next summer the Soviet Union will give a free trip into space to a French astronaut. Two candidates, Jean-Loup Chretien and Patrick Baudry, have been in training for more than a year. As is usual on the trips, one will fly and the other will act as his stand-in, or "double" in Soviet space parlance; both will be sent home after the mission, with no further chances to fly again. India has also agreed to provide cosmonauts. And observers think that Moscow may extend invitations to Western nations such as Sweden, Greece and Austria.

Meanwhile, according to rumours in the West, the Soviets are restarting development work on a "super-booster" that could lift 100 tonnes into orbit—about the same as America's now-retired Saturn-V. The first attempt to create such a vehicle ended in disaster when three rockets were destroyed in tests between 1969 and 1972. A redesigned craft could be launched within two or three years. The rocket could put a large station into orbit all in one launch, or even send Salyut-type modules into lunar orbit or to Mars. Once the Russians have devised the technology which makes it straightforward to keep people in orbit a few hundred kilometres above the Earth, there is no reason why they should not go further into the Solar System. □

The brain's chemical alphabet

SCIENTISTS have just reported results that reinforce a new view of brain function: that different types of nerve cells (neurones) use different chemical messengers to send signals to the brain.

The synapse is thought to be the major site of information transfer in the brain. Here, electrical impulses from one cell induce the release of a chemical (neurotransmitter), which in turn increases or decreases (depending on the transmitter involved) the electrical activity of a second cell.

Although each cell may receive several thousand synaptic inputs, early studies suggested that neurones could only synthesise one type of transmitter, and so could probably exert only one type of synaptic action. Early theories assumed that only a limited number of types of synaptic interaction occurred in the brain, and thus the number of neurotransmitters should be similarly restricted. Now neurobiologists are changing their views.

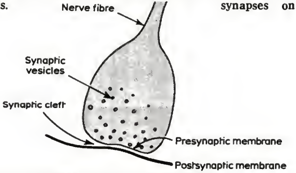
The first problem that neuroscientists have had to contend with is that the number of transmitters that can be found in the vertebrate brain is very large—much greater, for example, than the two required for a brain model based solely on simple excitatory and inhibitory interactions. Acetylcholine, and several amino acids and amines, such as glycine, glutamate, aspartate, 5-hydroxytryptamine, γ-amino butyric acid, dopamine and noradrenaline are now firmly established in neurobiologists' minds as possible transmitters.

But the major expansion has been in the number of known peptides. Over the past few years over 20 peptide hormones have been identified in the brain and many of these are thought to be stored and released at synapses. For example, the two peptides, "Substance P" and enkephalin are believed to control our perception of painful stimuli by modulating the flow of information in the spinal cord, whilst in the retina it appears that different catgories of visual information are processed by cells which can be distinguished both by their morphology and the peptide neurotransmitters they contain (such as neurotensin, somatostatin, VIP and glucagon).

Now G. Pelletier in Canada and Harry Steinbusch and A. Verhofstad at the University of Nijmegen in Holland have found that individual synapses may release more than one transmitter (*Nature*, vol 293, p 71). It has been known for some time that neurones are capable of synthesising more than one transmitter. Tomas Hökfelt and his group at the Karolinska Institute in Stockholm, for example, showed that some cells in the brain contain both the "classical" neurotransmitter, acetycholine, and the peptide VIP. Some dopamine-containing neurones also appear to contain the peptide, cholecystokinin.

Although neurotransmitters are synthesised in the cell body and then transported along the thin axonal process to the nerve terminals and synapses, the presence of a substance in the cell body does not necessarily imply that it is a neurotransmitter. Better proof can be obtained by examining the nerve terminals themselves, where neurotransmitters are known to be packed in concentrated form in tiny vesicles awaiting release. But here the technical problems are immense. A single vesicle is only 60-90 nanometres in diameter and can be seen only under the electron microscope. It may contain between one million and one thousand million times less neurotransmitter than the cell body so that the staining techniques must be that much more sensitive than their light microscope counterparts.

To achieve this Pelletier and his colleagues used antibodies specific for serotonin and Substance P. When they compared sections of brain stained for the two transmitters they found that both were localised within the same vesicles, thus undermining the "one neurone—one neurotransmitter" hypothesis, which has held sway since the 1930s.



Do nerve cells use a chemical morse code?

Why should two transmitters be necessary? Some clues were offered by Yuh Nung Jan of the University of California at the 9th Meeting of the International Neurobiology Society held earlier this month in France. He and the late Stephen Kuffler studied the synaptic responses of cells in the sympathetic ganglia (nervous tissue) of the frog—chosen because it is much more accessible for this sort of study than the mammalian brain.

Some of the inputs to individual ganglion cells liberate acetylcholine (ACh) whilst others release a peptide called LHRH. The post-synaptic response to ACh lasts for milliseconds, but the duration of the LHRH response can be seconds or minutes. In fact, four distinct types of synaptic response have now been identified and it seems there may be more. This suggests that the number of transmitters present in the mammalian brain may reflect the variety of synaptic interactions which occur.

An even more exciting observation made by Jan was that some cells which do not themselves receive the peptide input still respond when the LHRH synapses on neighbouring cells are activated. Presumably the chemical simply diffused from the synapse to activate specific receptors on the cell's surface. But more importantly the results suggest that in some cases synapses may not be required for information transfer. ☐

Careful when you breathe

VOLCANIC ASH from the eruption of Mount St Helens last spring does cause lung disease, according to a paper published in *Nature* (17 September, vol 293, p 216).

Researchers from the US National Institute for Occupational Safety and Health and from the Emanuel Hospital in Portland, Oregon, injected 10-milligram samples of ash collected from the city of Spokane into the lungs of rats. The ash provoked the growth of granulomas in the rats' lungs. Granulomas are tumours that indicate a mineral's ability to cause pneumoconiosis—the severe disabling illnesses such as asbestosis and silicosis caused by minerals and metals which got into the lungs.

SPL

Volcanic ash from Mt St Helens

The *Nature* paper says: "The granulomas produced in experimental animals resembled those associated with mixed mineral dust exposure". The US researchers conclude that their experiments "indicate that volcanic ash . . . should be considered a pneumoconiosis risk in heavily exposed individuals".

They confirmed their fears when they examined lung material from two loggers who died in the eruption. In both cases, the lungs showed changes consistent with the animal experiments. The researchers say: "We think precautions should be taken to monitor and minimise ash exposure in those likely to be heavily exposed". ☐

Lucky dip for the electronic future

Ralph Brookfield

AN ELEGANT technique for producing ordered layers of organic molecules — called Langmuir-Blodgett (LB) films—on solid surfaces has become the focus of intense research and close industrial-academic cooperation in the fast-expanding new sciences of molecular electronics and molecular optics. LB films have a wide variety of potentially important applications, including chemically and biologically sensitive semiconductor devices, integrated optics, luminous displays and solar cells.

British research is now coordinated by a Science and Engineering Research Council working party, chaired by Professor Gareth Roberts of Durham University, who hopes it will recommend promising new areas of research in the field for SERC financial support.

Work on some projects involving LB films is already well on the way toward coming up with some commercially useful devices. Part of Roberts's own work has been to develop a gas-sensitive microelectronic device (called the chemFET) that can monitor the presence of hydrogen, ammonia, carbon dioxide, or other potentially dangerous components of an industrial atmosphere.

The organic film that forms the heart of the new devices is transferred onto the surface of a semiconducting substrate by dipping the semiconductor through a floating film of aligned molecules, just a single molecule thick. The types of molecules that can be persuaded to float in this orderly way all possess a group of atoms with a chemical affinity for water, joined to a long water-hating hydrocarbon "tail".

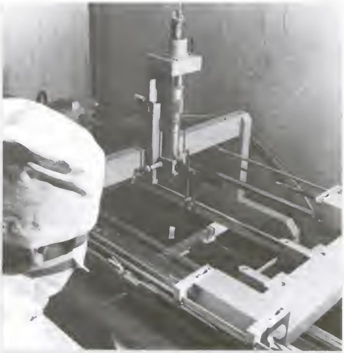
A minute quantity of such a substance, deposited onto an ultra-clean water surface, tends to spread out into a dispersed raft of molecules, each floating with its water-repelled parts clear of the surface. Over 50 years ago, Irving Langmuir and Katharine Blodgett, scientists at General Electric's Schenectady Research Laboratories, applied gentle pressure to the edges of these molecular rafts to produce the near-perfect floating monolayer films that now bear their names.

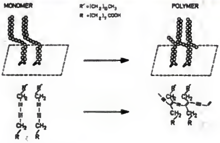
Langmuir and Blodgett went on to develop an apparatus (the Langmuir trough) with which they could dip solid substrates through the film at a carefully controlled rate matched to the constant pressure applied to the film's perimeter. By repeatedly dipping and raising the sample, they were able to stack layer upon layer of closely packed aligned molecules on its surface.

Researchers at ICI and Durham used a precision version of the Langmuir trough to deposit films of fatty acid molecules on slivers of the semiconductor indium phosphide (InP). By adjusting the conditions in the trough, they built up a series of tenacious monolayers, each about 2·5 nm ($2{\cdot}5 \times 10^{-9}$ m) thick.

With a metal electrode carefully positioned on the outer surface of the film, the resulting metal-film-semi-conductor sandwich has electrical properties very like those of the more conventional metal-silicon oxide-silicon structure used in devices such as the field-effect transistor (FET). In the FET, small changes in an electric field generated across the junction between the semiconductor and its insulating oxide (or LB film) coating control any current flowing through the semiconductor.

The work at Durham has shown that LB films on InP and other semiconductors can be controlled as well as oxide-silicon structures, at film thicknesses approaching 10^{-7} m (or several tens of monolayers). Roberts and his colleagues can now make their films durable enough to be used in practical devices by using stable organic molecules or by polymerising the LB film (see diagram).





Durham's Langmuir trough (left). Electron micrograph showing polymerised fatty acid film (above). Formation of polymer (below left)

Gases can penetrate this structure—something that is not possible with silicon oxide films—and weak chemical interactions between the gas and the organic film produce changes in the film's electrical properties. These changes affect the characteristics of the semiconductor-film junction, which are monitored by the chemFET's signal-processor electronics, also developed by the ICI/Durham team.

The next step from the chemFET, says Roberts, is a device that will mimic and register biological responses to changes in its environment.

Another potential electronic application for LB films is being investigated by Ian Shanks at the Royal Signals and Radar Establishment, Malvern. Shanks is studying films of molecules that have had electrically excitable groups, such as anthracene, grafted into the basic fatty acid structure. A current passed through an ordered stack of these molecules causes them to emit visible light as their bonding electrons jump between energy levels.

The Ministry of Defence hopes that Shanks will be able to harness this effect in a controllable "passive" display, similar to the now well-known liquid-crystal devices.

Interest in LB films is not confined to electronics. At University College London, Chris Pitt and his colleagues are using the same type of polymerised films as those in Roberts's chemFET to make microscopic guiding channels for beams of laser light. Networks of channels like these form the basis of integrated optics devices, designed to perform the same kind of logic functions with light beams as integrated circuits do with electric currents.

LB films could also help in making silicon integrated circuits—suitable monolayers could be used as electron beam resists. ☐

The cancer cascade: why the science is suspect

Stephanie Yanchinski

THE REVELATION that crucial findings in cancer research were based on false evidence has, thrown the cat among the pigeons. The experiments, carried out by Mark Spector and Efraim Racker at Cornell University, have prompted the US National Cancer Institute to take the unusual step of setting up a special committee to review its grants to Racker. Both Racker and Spector deny that they perpetrated any fraudulent experiments (either together or separately) and there is no evidence to prove who did it. But there clearly was a fraud by someone *(New Scientist*, 24 September, p 781).

How was it done? Why was the science concerned so important? The story starts with tumour viruses. There are two types of viruses associated with tumours, containing either DNA or RNA. Every organism, from bacteria to humans, has genes composed of either DNA (deoxyribonucleic acid) or RNA (ribonucleic acid).

Racker and Spector provided such an explanation. Their theory puts the energy pump of the cellular membrane at the centre of the stage. The energy pump is a biochemical mechanism for pushing sodium ions out of the cell in exchange for potassium ions. Racker and Spector's theory was that faults in the energy pump lead to at least some kinds of cancer.

The enzyme that provides the energy that powers the pump is ATPase; it catalyses the breakdown of adenosine triphosphate into adenosine diphosphate, a reaction that releases large amounts of energy. Racker and Spector theorised that cells became cancerous because this enzyme is faulty. The enzyme cannot operate efficiently in cancerous cells, according to their theory, because it carries an extra phosphate group that literally gets in its way.

Sometimes, RNA tumour viruses go further: they transform their host cells into cancers that grow rapidly and spread to other parts of the body. The agents responsible for inducing cancer are special genes called oncogenes, which, scientists believe, the tumour virus poached from the host's cells in the past. This oncogene, once residing in the host cell's nucleus, still codes for a protein that has a normal role to play in the cell. But now the "quiet" gene is under the influence of a viral promoter. Under instructions from the captive gene and the viral promoter, the infected cell manufactures so much protein that the delicate metabolic balance of the cell is upset and it becomes cancerous. But such "recombinant" viruses are very rare in nature.

Much more common are viruses whose genetic material moves into the chromosomes of the host's cell as part of its normal life cycle activating adjacent genes which, again under the relentless drive of viral promoters, produce an excessive amount of particular proteins.

What is lacking in this theory is an explanation of how the proteins produced under the influence of the virus upset the smooth running of the cell's chemical factory. The whole mechanism is rather like a series of waterfalls—when one overflowed, so did the others. It was christened the "kinase cascade".

Tumour viruses fit into this picture because, Racker and Spector thought, they started the waterfalls flowing. Their theory received its first experimental support when Spector discovered a kinase (called PK$_M$) that phosphorylated ATPase and so damaged the membrane pump.

Spector says that he had isolated four kinases—PK$_S$, PK$_L$, PK$_M$, and PK$_F$—from the membranes of tumour cells grown in the guts of mice. The four kinases form a cascade, with PK$_M$ completing the chain by phosphorylating ATPase (*Science*, vol 209, p 303).

The next step in the argument took flesh when Racker and Spector said that one of these kinases—PK$_F$—had the same molecular weight as a kinase produced by a viral oncogene—the "sarc" gene of a Sarcoma virus (which produces tumours in the connective tissues of birds). Spector and Racker believed that the product of the sarc gene and PK$_F$ were one and the same chemical.

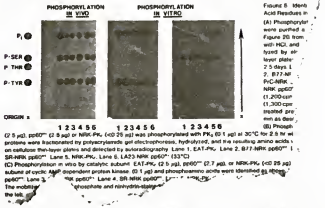
Spector was the principal author of the paper that produced evidence of this crucial identity (*Cell*, vol 25, p 9). The evidence was that antisera against PK$_F$ and against blood from rabbits infected by sarcoma tumour viruses *both* precipitated a protein of the same molecular weight (60 000 daltons) isolated from other tumour cells. Of course, the final proof that the two molecules are the same would be that they have an identical sequence of amino acids along their length. And the *Cell* paper does indeed claim that "maps" of the two proteins are closely similar. Spector made his "maps" by a standard procedure of digesting the proteins with enzymes and then running the free amino-acids on an electrophoretic gel. Electrophoresis is a technique in which molecules migrate through a gel under the influence of an electrical field—the distance the molecules move through the gel depends on their size and charge. In effect, it pulls apart a mixture of amino acids into a pattern characteristic of the protein.

There are two crucial elements that led researchers to doubt Spector's experimental work. One involves Ray Erikson at the University of Colorado. Erikson works with sarcoma viruses and discovered the first protein clearly closely associated with this virus. It was a kinase that phosphorylated the amino-acid tyrosine. Jo Kraft, who works in Erikson's lab, told *New Scientist* they had supplied Racker with antisera to this sarc protein in exchange for antisera to Spector's kinases.

Each was to have used the other's antisera to precipitate his own protein and thus prove them identical. But it didn't happen that way. Erikson's antisera contained antibodies not only against the sarc protein but also against various bits of the virus. Spector's antiserum, on the other hand, should have been much purer. To his surprise, Erikson found it wasn't—Racker and Spector's antiserum also reacted against the viral particles.

Later Erikson received another antiserum from Spector (against the kinase PK$_S$) which should have precipitated a molecule of 57 000 daltons. It didn't.

The second piece of disturbing evidence about Spector's experiments was uncovered by Volker Vogt, a biochemist also working at Cornell. The trouble with the electrophoresis technique that Spector used to map his kinases is that you cannot see the maps of amino-acids. Researchers overcome their "blindness" by labelling the amino-acids with radioactive phosphorus-32 before they start. Vogt discovered that some of Spector's kinases contained radioactive iodine—an element that had no business to be there at all. □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PHOSPHORYLATION IN VITRO
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Figure 5 Ident
Acid Residues in
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were purified a
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min as desc
(B) Phosph
(2 5 μg), pp60 (2 5 μg) or NRK-PK$_F$ (<0 25 μg) was phosphorylated with PK$_S$ (0 1 μg) at 30°C for 2.5 hr wi
proteins were fractionated by polyacrylamide gel electrophoresis, hydrolyzed, and the resulting amino acids
on cellulose thin-layer plates and detected by autoradiography Lane 1, EAT-PK$_F$ Lane 2, B77-NRK pp60
SR-NRK pp60 Lane 5, NRK-PK$_F$. Lane 6, LA23-NRK pp60 (33°C)
(C) Phosphorylation in vitro by catalytic subunit EAT-PK$_F$ (2 5 μg), pp60 (2.7 μg), or NRK-PK$_F$ (<0 25 μg)
subunit of cyclic AMP dependent protein kinase (0 1 μg) and phosphoamino acids were identified as above
pp60 Lane 3 RK pp60 Lane 4, SR-NRK pp60
The mobility phosphate and ninhydrin-stain
the left.

It was plates like this that aroused Volker Vogt's suspicions about Spector's work. Each column on each plate is the amino-acid "map" of either a kinase or the protein product of the sarcoma virus. The fact that the patterns of the two are identical was evidence for Racker and Spector's theory that the two proteins are the same. But Vogt discovered that Spector's "maps" had been cunningly doctored: the pattern was from radioactive iodine, not phosphorus

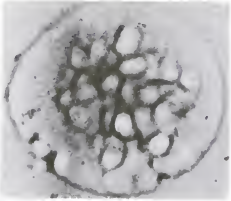
MONITOR

Skeleton in the cell shows up on X-ray resist

THIS MAY look like an out-of-focus picture of a section through a pomegranate, but actually it is a rather remarkable image of dark filaments—perhaps of muscle—in a blood platelet just 3 micrometers across. The round light areas are vacuoles—membranes filled with fluid.

Ralph Feder, Praveen Chaudhari and David Sayre of the IBM Thomas J. Watson Research Center at Yorktown Heights, New York, and Jonathan Costa of the National Institute of Mental Health, Maryland, have made the filaments visible for the first time. They mount the cell on a photosensitive resist and then bombard it with X-rays. The various parts of the cell absorb different proportions of the X-ray beam; the pattern of chemical changes in the resist reflects the intensity of X-rays coming through, just as in a conventional photograph.

The resist can record much smaller features—in this case only 1/20 of a micrometre across—than a conventional photographic film could. After the resist has been chemically etched to reveal the detail in the image it is examined in a transmission electron microscope (TEM) which forms an image from electrons that pass through the sample. The TEM can see much finer objects than a conventional electron microscope, in which electrons bounce off the sample.



IBM

The catch is that the TEM can look only at very thin samples: the resist is thin enough, but the cell itself is not. By using a resist, scientists can combine the advantages of a thick cell in an almost lifelike state with the precision of the transmission electron microscope.

The scientists have also used the technique to image the long fibres that platelets send out when blood clots. These "pseudopods" become entangled to help form the clot. The X-ray pictures show for the first time that the fibres originate inside the platelet, rather than being extensions of the cell's outer membrane. □

Cosmic background not so perfect

IMPROVED OBSERVATIONS of the cosmic microwave background radiation are beginning to show up small deviations of its spectrum from that of a perfect black body radiator. These imperfections in the black body background are not sufficient to pull the rug from under the accepted explanation of the radiation as a relic of the big bang of creation. But they do provide hints of how the big bang itself deviated from perfect uniformity, and may eventually lead to an improved understanding of the early history of the Universe.

Writing in *Physical Review Letters* (vol 47, p 745), H. P. Gush, of the University of British Columbia, Vancouver, describes measurements made on a rocket flight of the sub-millimetre wave spectrum of the cosmic background. These are the first such observations reported, and they show a bump in the spectrum between wavenumbers 11 and 20 cm^{-1} (roughly 1 to 0·5 mm wavelength) where the observed intensity exceeds that expected from a perfect 2·7 K radiator. Gush says that, "no convincing explanation for this feature can be offered". □

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Battle against software piracy begins

SUPPLIERS OF SOFTWARE for personal computers are locked in a battle of wits with their customers over the making and breaking of devices designed to stop programs from being copied. As fast as the suppliers devise a new protection method, programmers—usually hobbyists—learn to unravel it.

In the US, where personal software worth around $200 million is sold each year, suppliers estimate they are losing between $12 million and $36 million in revenues. A British producer of games programs told *New Scientist* that at least five copies were made for each program he sold. Most games are bought by hobby computer owners, who are reckoned to be the worst offenders. Some suppliers have withdrawn games from sale after as little as six months, because there were too many pirated copies in circulation.

The latest weapon in the pirate's armoury is the controversial "bit map copier", a piece of software designed to get round protection routines built into floppy disks. Most of them—with names like Locksmith and Copywrite—are designed for Apple computers and allow a high degree of protection to be built into software. When they first appeared in the US, software suppliers persuaded magazines read by computer enthusiasts not to take advertisements for copiers, but even so they were unable to stem the demand.

That demand for copiers has been fuelled by the software companies' own sales policies. Most of them refuse to supply cheap back-up copies, so if a user wants to insure himself against accidental destruction of his master copy he has to buy two full price disks at anything up to £500 each.

Typical of these copiers is Copy II Plus. Recently launched in Britain at £39·99, Copy II Plus has been promoted as being able to break protected software packages in under one minute. John Chesney, managing director of its distributor, Apple Orchard, does not believe he is doing anything wrong. "I am against piracy," he says. "But the responsibility for that is collective and can't be laid at my door." Ironically, Copy II Plus is not protected at all and anyone can duplicate it.

There are many ways of protecting software. The commonest method in the Apple is to change the format of the data held on a disk. This is done by making it impossible to recognise the beginning and end of sectors of the disk. The sectors are equivalent to partitions in a filing cabinet and are usually 256 Bytes long. Sometimes the codes that indicate the start of sectors are changed, or alternatively the time intervals between sectors can be varied.

To allow the computer to read the disguised data a special operating system is held on the disk. This is loaded into the computer and replaces the standard operating system. At the same time the keyboard which would allow programmers to look at the secret operating system is locked out.

Using a copier like Copy II Plus a programmer can go through a series of tests that will reveal which of these methods has been used and produce an operating system that will run the program.

There are, however, other copy protection devices beyond the scope of the bit map copier. For instance, many programs written for the Pet computer make use of a device known as a dongle. The dongle is an extra piece of memory that is plugged into the computer, without which the program refuses to run. The dongle can be broken by printing out the program and searching for the computer code which checks on its presence. All the programmer has to do then is remove that code and his copied programs will run on machines without the dongle.

To try to stop copying, the manufacturers of games software have attempted to make it uneconomic by making their products cheaper. Over the past six months the average cost of a games package has fallen by about 20 per cent. ☐

Electronic maths

TEXAS Instruments is selling a £35 educational toy which poses mathematical problems in an electronic voice. "Speak and Maths" works on the same principle as the company's Speak and Spell, which was the first domestic product to incorporate speech synthesis circuitry. But the new toy stores a wider range of information in its memory.

Speak and Spell helped children to write and pronounce words by synthesising the sounds of words and individual letters which the user has to key into calculator-style keyboard. But its vocabulary was limited to 200 words. Speak and Maths has a memory with more than 100 000 mathematical problems on call. These are displayed at random on a calculator display. The child is asked by the synthesised voice to key in appropriate answers. When the answer is correct, the voice congratulates the child; when it is wrong the pupil is given a second try and then told the correct answer. The problems are grouped into three levels of difficulty, which the child can select before challenging the toy.

In addition to addition, subtraction, multiplication and division, the machine's circuits also play a game called Number Stumper. Multi-digit numbers are randomly generated but not displayed. The child tries to guess the numbers and the synthesised voice gives clues. ☐

Mathematical brother of the Speak and Spell

Furnace helps glass-makers to pick up the pieces

GLASS-MAKERS in the Third World could benefit from an electric furnace and glass-blowing machine specially developed for the needs of Sri Lanka by Intermediate Technology Industrial Services (ITIS) of Rugby. Three of Sri Lanka's small glassworks have gone out of business since 1977 when the government lifted import restrictions to allow competition from big, automated glassworks overseas. Sri Lanka's Industrial Development Board asked ITIS to help the industry and a team including members of the glass-melting furnace-makers Penelectro visited Sri Lanka. The team designed a hydro-electric powered furnace, the first example of which has now been commissioned. ITIS says that the design enables small glassworks to start production in any rural area with the right raw materials (sand, limestone and soda ash), and with relatively cheap hydro-electric power.

Because the new furnace utilises higher temperatures than most commercial processes, operators can feed it with raw materials alone, rather than a mixture of remelted waste glass—cullet—and raw materials. Fresh raw materials added on top of melted glass act as an insulator and improves the efficiency of melting. ☐

TECHNOLOGY

Slow start for laser video-disc factory

There are many pitfalls between the raw perspex disc and the complete Laservision product. And it takes operators eight hours to make each one

IT TAKES operators at Philips's new video-disc factory in Blackburn, Lancashire about eight hours to complete the process of making and testing each disc, starting from a raw perspex blank to the finished glossy item. The factory can produce little more than 100 discs per eight hour shift at present. The task is extremely labour intensive and is so costly that Philips will have to stomach losses for at least a year after the company starts selling the discs. Even the date it starts doing that, which has already slipped twice due to the technical difficulty of producing perfect discs, is still not certain. Failure rates vary between 10 to 90 per cent, and are quite unpredictable.

Philips allowed journalists from *New Scientist* and a handful of other papers to visit the Blackburn factory two weeks ago, the first time the factory has been opened up to anyone not associated with the company's video-disc plans. Although the Laservision technology is way ahead of any other video-disc system, the factory is not—at least not yet. The company is having great difficulty in making the consecutive production steps work reliably and repeatedly. Only when it has solved this problem will it be able to automate each step, thereby increasing production rates and cutting costs.

In contrast, JVC's video-disc factory in Yamato near Tokyo which *New Scientist* has also visited, uses conventional equipment originally designed to produce audio discs, though of course it is suitably modified. Although the discs are less advanced the production process benefits from automation of the existing production lines and the Japanese VHD discs roll off the line every 40 seconds.

The main problem bugging the Blackburn staff is the low, and unpredictable, output of perfect discs. This has been a problem all along but the factory staff can now control systematic faults, caused for example by a poor "stamper" affecting all discs in a run. But they still cannot master random defects, where for instance some discs from a good stamper unaccountably prove to be faulty. At Blackburn, between one and nine out of every 10 discs produced turns out to be satisfactory.

Each disc, carrying two hours of programmes, must be viewed in its entirety. Quality control engineers each watch four players and screens at the same time. Although the factory can have up to 44 players working simultaneously, five days a week on two shifts (soon to be increased to three), this checking procedure is not fast enough for commercial production.

Philips is experimenting with electronic circuits that can link defects in a disc's performance to visible blemishes. This will automatically sort good from bad pressings. But it is not yet reliable.

Philips provides a custom-pressing service for the companies that supply the programmes. These arrive at Blackburn on video tape. Engineers modulate the beam of a 100 MW laser with the tape's signals and focus it onto a rotating glass disc coated with a photosensitive emulsion. When the exposed disc is developed and etched, it holds a spiral track of some 25 000 million pits. Next an engineer coats the master discs with silver and replays it to check its quality.

If the disc is acceptable, the next stage is to electroplate it with nickel and coat it with aluminium to produce a "father" disc: this negative replica of the master is stripped from the glass, and electroplated with nickel to produce a "mother". This is a positive replica of the original master and from this another electro-nickel plating process produces a negative "son" or stamper, which is used in the production process. The stampers are used to make "half" discs, pairs of which are glued together to make the final double-sided product.

It costs Philips at least £5 for each usable disc the factory turns out. But to allow the film companies to sell feature films at £15 a time, as promised, Philips must sell them finished discs at around £3·50 each. ☐

Lucy woos British Telecom's information users

THIS WEEK British Telecom loses control of the services its customers can obtain on public telephone lines. With perfect timing, the rivals are staking their claims to provide those customers with private services, including viewdata. And the contestants will fight for the favours of Lucy, the chip made by Mullard that can turn your TV set into a terminal for an armoury of hardware for information technology (*New Scientist*, 19 March, p 744).

In the lead so far is Tangerine Computers of Ely, which claims to have 76 per cent of the market in providing Prestel to new customers of British Telecom's viewdata service. Tangerine's Tantel device (called a modem) connects a standard colour TV set to a telephone socket to convert incoming Prestel signals from 1200 pulses per second to the 75 pulses that a TV can handle. Recent versions of Tantel turn a TV screen into a colour terminal for a personal computer and include an alphanumeric keyboard. Tantel, which costs £170, will allow its owner to receive private viewdata through "gateway" software—when the software is available.

But hot on the scene has come a modem from Rediffusion Computers of Slough, Berkshire that also uses the Lucy chip. Rediffusion has announced a group of products that include a portable TV set with a modem built in, and a personal computer. The computer will control a user's choice of viewdata pages and will also provide remote control of a Sony U-Matic video cassette recorder, Philips's Laservision videodisc player when it is available (see above), and call up pages of videotext—Oracle and Ceefax. Most importantly, Rediffusion's modem is designed to link a television set to private viewdata computers, as well as Prestel's. Information will arrive from private databanks through British Telecom's packet switched data network, which can cut the cost of sending large chunks of data over public networks during peak business hours by some 90 per cent compared with subscriber trunk dialling (STD).

Unlike Tangerine, Rediffusion will not sell its new system to private individuals. It is designed specifically for business and its cost is determined by packages of hardware and software that Rediffusion can supply. For instance, the basic screen, modem and computer costs £750; with disc drive for data storage, the price would jump to about £4000. ☐

TECHNOLOGY

When nuclear disasters stop for lunch

BOILER AND GAS CIRCULATOR 32
BOILER AND GAS CIRCULATOR 33
BOILER AND GAS CIRCULATOR 34
TURBO-GENERATOR AND FEED

No crisis in the control room at Dungeness B power station in Kent

NOW AND AGAIN Britain has a "nuclear incident" as serious as the one at Three Mile Island in 1979. And they all occur in the vicinity of Oldbury nuclear power station, near Bristol.

By less than chance, *New Scientist* was recently on hand to witness such an incident. In this case, the panel in a reactor control room suddenly indicated that the containment vessel that keeps the coolant—carbon dioxide gas—inside the reactor had sprung a leak. Carbon dioxide that should have been cooling the reactor's core was roaring through a gaping hole.

Despite all the warnings, the reactor operator did nothing. But there was no cause for alarm. All the automatic controls came into play and the reactor shut itself down safely. In all, the incident lasted about 10 minutes. Then it was time for lunch.

The only "damage" that resulted from the event was the cost of the telephone line connecting the control room at Oldbury to a large computer at the headquarters of the Central Electricity Generating Board in London. At Oldbury, the CEGB has built control desks for a nuclear power station. They are identical to those in the generation of advanced gas-cooled reactors (AGRs) that is now coming on line. And the nuclear emergency was a training exercise on the control desk that matches exactly the desk at Hinckley Point B AGR.

Much of the time the simulator helps to train reactor operators in what they should do when things are going right in a reactor; but every two years, if not sooner, all trained operators have to return to the Oldbury Nuclear Power Training Centre for a refresher course. That is when the fun starts.

Operators run reactors in shift teams of 6 to 10 people, the number depending on the type of reactor. And the operators return to the NPTC in whole shifts. Let a shift loose on the simulator and its members will concoct increasingly cunning incidents to baffle their colleagues. But according to the tutors at the centre, things get really interesting when "some know-all" comes along. These are the people who make mistakes when something out of the ordinary occurs.

Peter Myerscough, who runs the centre, thinks that you have to be careful to use simulators properly. There is one school of thought that says put someone on a simulator long enough, and he will experience all the things that can go wrong and will respond correctly when the reactor starts misbehaving. This approach horrifies the CEGB's training experts. Simulators might be good at making reactor operators out of the inexperienced, but the board insists that its operators know what is going on inside a reactor. Thus they will be able to interpret dials and the graphs on the visual display units that are increasingly common in reactor control rooms. The aim is that operators should know just what is happening within the core and the power station's steam and electricity circuits. In this way, they will be able to spot the sort of mistake that happened at Three Mile Island, when the instruments were providing information that the operators could not understand, or chose not to believe.

There is now talk of the US adopting an approach to reactor operator recruiting and training more like Britain's, where all operators have to reach degree level, or its equivalent, in science or engineering. Most people who train to become reactor operators have worked for the CEGB for at least two years in some other job. After the training, the CEGB has a highly qualified individual, with a fairly sophisticated understanding of what makes a nuclear power station tick. And yet most of the time, these technically skilled people have to while away the hours watching nothing happen. That is the art of good reactor operating.

Britain's nuclear power stations may cost a lot to build, but they are so cheap to run that it makes sense to keep them steaming away at full power, churning out as much electricity as possible. This can be pretty boring for the operators, the highpoint of whose lives is refuelling the reactor—something that happens once every few years.

It isn't easy to combine the two attributes: enough intelligence and education to understand the inner workings of a nuclear power station; and the doggedness needed to sit watching rows of unchanging dials and television screens for weeks on end. This is one reason why the operators also spend time on the routine maintenance and testing of the power station's components.

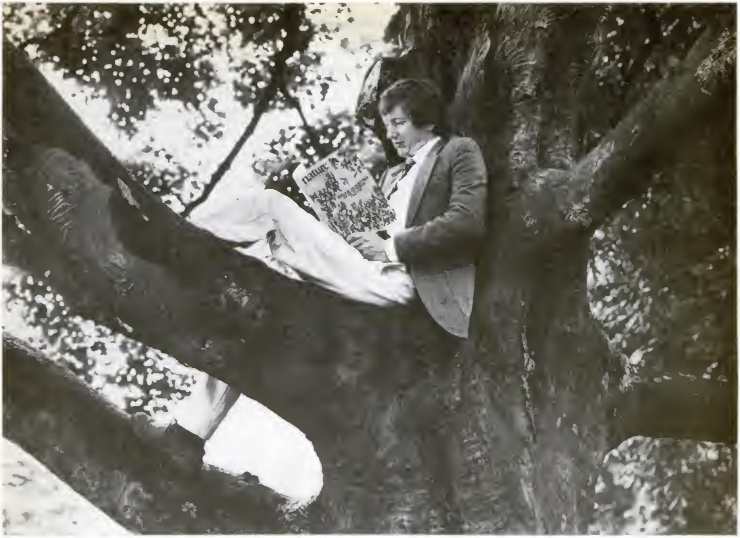
The CEGB is now training the people who will operate the new AGRs at Dungeness, Hartlepool and Heysham. It takes about six months to train an operator, and the board likes to have the teams for a new station trained six months before it starts to load fuel into the reactors. ☐

Germans plan machine to detect cancer

WEST GERMAN researchers are working on a portable machine that could speed up the detection of cancer. About 150 000 people die of cancer in West Germany every year; for many of them, doctors diagnose the disease too late for treatment to succeed.

In the £600 000 project, the West German Cancer Society and the Max Planck Institute are developing a device called a cytometer. The machine measures the size and optical characteristics of human cells to determine if they indicate cancer. The cytometer already exists, in a large and bulky form. Scientists want to reduce it in size so that it is portable and costs only about £25 000—within the budget of hospitals and even groups of general practitioners.

In many cancer detection techniques, doctors spot cell abnormalities only if 5 to 10 per cent of the cells in their samples are diseased, by which time the cancer is advanced. The new cytometer should be able to detect cancer cells at a much earlier stage, when they comprise from 0·5 to 0·8 per cent of the sample. Apart from its value in diagnosis, the cytometer should be a valuable research tool. It could help doctors to find out why tumours send out metastases (cancer cells) when they reach a certain point in their development, and how the body reacts to cancer. ☐



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One hundred Manhattans in the sky

Huge satellites 35 000 km above the Earth could provide the planet with energy from the Sun. For sound technical and economic reasons, Western Europe would do well to study the idea

Peter Marsh
has been talking to
Patrick Collins

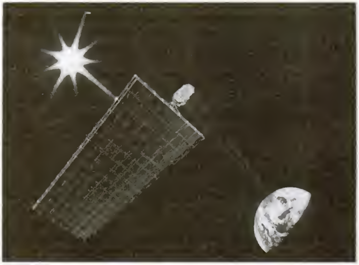
Although the US has done most of the work in preparing for a series of satellites to collect energy in outer space from the Sun and beam it to Earth, Western Europe stands to benefit more from the project, because of its extreme shortage of energy resources. It has to import two-thirds of its energy; and official projections do not foresee this figure falling below 50 per cent for the next 40 years.

So even with more nuclear power stations and programmes to encourage conservation and the use of renewable energy resources, Western Europe still needs major new sources of energy if it is not to be seriously short of power early next century. It is therefore surprising that the satellite power system (SPS) has received no research funding from the EEC. This is in contrast with the £150 million per year that Western Europe is spending to investigate nuclear fusion—another big project which could solve many of the world's energy problems.

The SPS would be a network of perhaps 100 satellites in geosynchronous orbit 36 000 km above the Earth. Each 5 GW satellite would be 10 km long and 55 km wide—roughly the size of Manhattan—and weigh 50 000 tonnes. One surface would be covered with silicon cells to convert solar energy to electricity; an array of microwave tubes would transform the electricity into radiation which would be sent to a receiving antenna (rectenna) on Earth. The rectennas—there would be one for each satellite—would convert the microwaves to electricity and conduct it to centres of population. Each satellite in the project would cost somewhere between £7000 million and £20 000 million.

In Europe, the SPS has unfortunately fallen between two stools. Because it involves largely space technology, energy researchers have not been keen to study the project. And the sheer cost and size of the SPS is outside the experience of Europe's small space community. Nonetheless, the basis of a cooperative effort on the SPS already exists in Europe. The European Space Agency has studied the subject since 1976, although it has no full SPS research programme. In particular, the agency commissioned Hydronamic, a Dutch firm of civil engineers, to investigate sites in Europe for rectennas—which would be huge structures covering 100 sq.km. Among the sites the firm proposed are several in the North Sea (see opposite page).

Engineers in France and West Germany have also examined the concept of an SPS; and Britain has not lagged in commissioning studies. In 1978-79, General Technology Systems and the Royal Aircraft Establishment (RAE) investigated the project for the Department of Industry. This was followed in 1979-80 by a larger study, also for the department, by British Aerospace, ERA Technology, Marconi Space and Defence Systems, and the RAE. British Aerospace has also looked into the production of very large solar arrays—and is producing such arrays for NASA's Space Telescope, which a shuttle is to lift into space in the mid-1980s. On behalf of the Home Office, a team at the University of Sussex has examined how beams from the SPS could affect the transmission of radio waves; while at Imperial College, London, researchers have studied several aspects of the project—including the possibility of constructing a rectenna off the east coast of England.


Twinkle, twinkle, big satellite

NASA/Space Frontiers

Several technologies that would be important in an SPS are already under study—control systems to position objects accurately in space and the design of large satellites for instance. But engineers will have to look at a number of specific problems in detail before Europe can afford to take the SPS concept seriously. In particular, Western Europe needs to research the transmission of power through space as electromagnetic waves. Although the continent's microwave industry is involved in many areas relevant to solar power satellites—high-power radiofrequency generators and phased-array antennas for instance—it has done no experimental work on transmitting or receiving power in the form of microwaves.

Countries in Europe would do well to prepare for a series of experimental satellites that beam energy to Earth using this form of radiation. These craft need not be very large; they could fly in the early 1990s if work begins soon. A project to build such vehicles would be ideal for international cooperation because its objectives are scientific rather than commercial.

Also, space planners would have to prepare to mass produce solar cells very cheaply. Each satellite would contain some 1000 million cells; and to be competitive they would have to cost £150 for every kW that they produce—which is 5 per cent of the price of the cells that are used on Earth today.

This is clearly a difficult target, but there is no reason why it should not be met. The US's Department of Energy has set its own target for 1986; by this time it wants to see solar cells selling for $700 per kW. This figure probably will not be achieved for single-crystal silicon cells, but it may well be for other, newer types of cells—those made from amorphous silicon or cadmium sulphide for instance. An American company called Energy Conversion Devices is already planning a plant that, by 1985, should be turning out amorphous silicon cells for less than £500 per kW. These "thin-film" cells will come out of the factory in rolls—rather like sheets of glass fibre—at the rate of thousands of square metres per day The cost should reduce further as the market for solar cells increases and firms in the business start to make the devices in large volumes, rather as electronics firms now turn out microchips.

A serious difficulty about the SPS is the volume of material that engineers would need to take into space to build the solar platforms. Hundreds of tonnes of material would have to be lifted off the Earth every day. (Ultimately,

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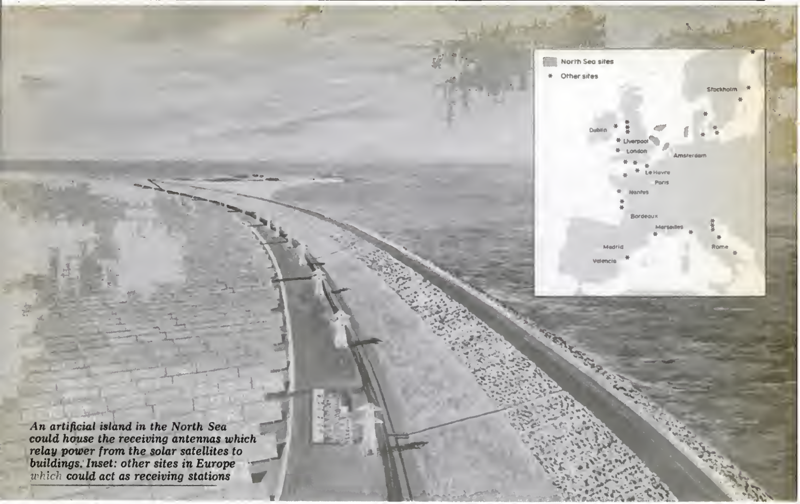


An artificial island in the North Sea could house the receiving antennas which relay power from the solar satellites to buildings. Inset: other sites in Europe which could act as receiving stations

we may be able to build such platforms from minerals mined from the Moon: a NASA study has reported that 90 per cent of an SPS could be built from the silicon, oxygen and the various metals found in lunar rock.) Planners in the US think that to build a complete solar power system, reusable vehicles like the shuttle, only with far bigger capacity, would be needed. These might carry loads of as much as 400 tonnes, compared with 30 tonnes for the shuttle. With this type of launcher, two satellites could be finished every year. To meet the cost targets for the SPS, the "space freighter" would have to put goods into orbit for about £25 per kg, or 5 per cent of the equivalent cost for the shuttle. Again, the target is stiff, but in view of the price reductions achieved in a few decades in other areas of the aerospace business—ferrying people across the Atlantic for instance—the target is not impossible.

Another key area, which at present we know little about, concerns the physical work of building things in space. We do not know how long construction jobs will take nor how much of the work will be done by machines and how much by people. Over the next few years, some of the answers should become clearer. The space shuttle will test an automated beam builder which joints aluminium or plastic rods into lattice structures. These can be fixed together to make large frameworks of the kind that, with many hundreds of similar ones, would be required in solar-power satellites.

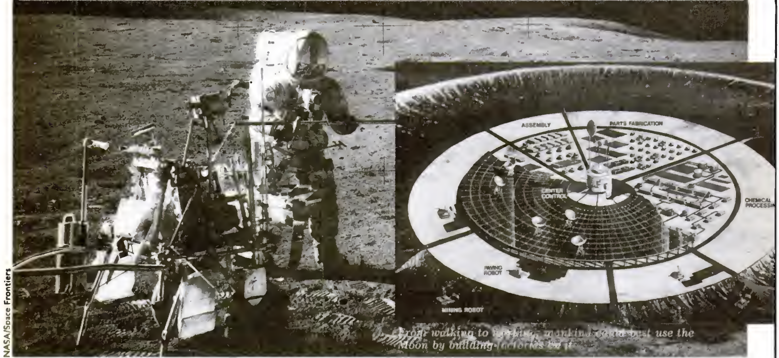
From a general economic point of view, there is a strong case for Western Europe studying an SPS because of the way the project would affect the whole shape of industry over the next few decades. Western Europe imports energy and raw materials from the rest of the world, and exports manufactured goods and technological know-how. As the developing countries industrialise, they are competing over an ever-growing range of industries—textiles, steel, shipbuilding, consumer durables, motor vehicles, civil engineering projects and petrochemicals—in which, formerly, businesses in Europe were dominant. As a result of this competition, the most highly-developed nations need to find new projects and industries in which to invest if they are to maintain their standards of living. The SPS project would use advanced technologies in which Europe has a lead. In Britain, skilled manpower is one resource which we have the ability to expand as required, and our aerospace and related companies could remain competitive in the production of satellite systems long after our lower-technology industries have succumbed to foreign competition.

The SPS would rapidly turn into a big new industry. At any one time, several hundred people would be working in space to construct the platforms; and the project would require many times this number of technicians and engineers on Earth. Later, there would be other developments. The continuous availability of solar energy in space would make it economic to site factories in orbit rather than on the ground. And, ultimately, people will mine bodies in the Solar System, such as the Moon and the asteroids, for minerals which the space factories will process. The EEC imports virtually all its chromium, cobalt, nickel, tin, copper, manganese, titanium, tungsten and half of its aluminium, lead, zinc and iron. The only way that the EEC can reduce this dependence on other countries is to explore ways of obtaining the materials from space.

In constructing the SPS, we would be developing the capabilities to create a future where shortages of energy and materials need no longer be feared. That is why Western Europe should be doing at least some research into the concept. ☐

Working on the Moon

If people are serious about making goods in space, then the natural place where we should both mine materials and site factories is our nearest neighbour in the Solar System—the Moon



From walking to working, mankind must use the Moon by building factories on it

NASA/Space Frontiers

David Criswell and Peter Marsh

Industrial development in space offers the world the prospect of, for perhaps the first time, real accumulation of wealth. Over the centuries, the Earth has accumulated people, capital and knowledge: but it is not clear that the gains have outweighed the losses in terms of the materials we have consumed. The resources of outer space are limitless. If we can tap just some of them—the dusts of the Moon or the solar energy radiating uselessly into space—the Earth can achieve real economic growth while hardly touching its own resources.

The Moon is the natural object to consider as our first source of space materials. We know how to get to it—though no one has done so for almost a decade—and quite a lot about what it contains. The Apollo landings collected 385 kg of lunar soil. Scientists around the world have worked for an equivalent of 10 000 years examining the composition of the Moon and the fruits of their research are documented in hundreds of thousands of pages of well indexed literature. The evidence is startling. The Moon is rich in oxygen, silicon and metals such as iron, aluminium and titanium. Indeed, as Table 1 shows, many of the 17 most commonly-used elements on Earth are abundant on the Moon. If we do not count hydrocarbon fuels, lunar materials could provide 90 per cent of the goods that are now made from non-recoverable Earth materials.

The Moon contains very little hydrogen and carbon—the basis of hydrocarbon fuels; but space provides huge opportunities to tap solar power, perhaps by building solar-power satellites above the Earth (p 28)

Space promises not only to help us forget the threat of materials shortages; it also provides unusual conditions in which engineers could make goods which are difficult or impossible to produce on Earth. Low gravity would allow us to study and control the mixing of fluids, gases and solids which, on Earth, separate out because they have different densities. It also allows handling without containers—and therefore the manipulation of unstable compounds which normally react with the walls of their receptacles. When molten materials solidify on Earth, gravity often produces stirring and mixing effects that hamper the growth of crystals and certain kinds of alloys; in space we should be able to obtain pure materials that are virtually impossible to make under terrestrial conditions. Further, space offers huge amounts of solar energy which could be most useful in manufacturing processes.

It seems sensible to cash in on both these sets of circumstances—a wealth of resources and favourable conditions for manufacturing—by building factories to process non-terrestrial materials not on the Earth but in space itself. Initially, the factories would orbit the Earth on big space platforms. Most of the raw materials would come

Table 1. How the Earth and Moon compare

Element	*% by weight in non-fuel resources used in US in 1968*	*% by weight in soil sample taken by Apollo 14*
Oxygen	45·5	41·3
Silicon	24·4	21·6
Calcium	14·1	6·9
Carbon	5·7	0·01
Iron	4·8	15·3
Aluminium	0·2	5·4
Magnesium	0·2	6·8
Copper, zinc and lead	0·2	0·002
Potassium	0·2	0·1
Phosphorus	0·2	0·05
Nitrogen	0·8	0·01
Sodium	0·9	0·2
Sulphur	0·6	0·1
Chlorine	1·4	0·001
Hydrogen	0·2	0·01
Other elements	0·6	2·3
	100	100

David Criswell is a visiting research physicist at the California Space Institute, University of California, San Diego.

from the Earth's nearest neighbour in the Solar System—the Moon.

The space shuttle shows the limitations of our efforts to take things into space from Earth. By the mid-1980s, shuttles should be flying to an orbit 300 km high roughly 10 times a year. Each trip will take into space just 30 tonnes of material—at a cost of some £15 million. Clearly, even with a fleet of shuttles, the mass of goods that could be produced in space from Earth-bound materials is very small. Due to the low gravity and lack of atmosphere on the Moon, however, the engineering systems needed to move materials off this body could be a hundredth of the size required on Earth—and consequently much cheaper. This was graphically illustrated by the rockets that lifted the Apollo astronauts from the Moon: they were feeble in comparison with the mighty Saturn launchers that blasted them from Earth.

Ultimately, the space factories would be transferred from an orbital position to the place from which most of their raw materials are mined—the Moon's surface. The first Moon plants could be based on the space operations centre that NASA engineers want to place in orbit above the Earth within the next 10 years (Box A). These Moon factories could build up the capacity to supply lunar

A. Moon factories could increase output by self-replication

Engineers in NASA would like to establish a permanent space station above the Earth in which scientists could run experiments and, eventually, make objects in the unusual conditions of outer space. Two schemes have been proposed. The Johnson Space Center in Houston wants to build a £3000 million space operations centre which would orbit some 300 km above the Earth with enough room for 8 to 12 people. A less ambitious plan, from the administration's Marshall Space Flight Center in Huntsville, involves a number of Spacelab modules lashed together in space. Three to six people could live for up to three months at a time on this £1000 million platform, doing experiments or perhaps running fully-fledged space factories. If NASA wins approval from the government, the platform could go into orbit in 1986 or 1987.

Space planners think that a base such as the space operations centre could be established on the Moon. The installation could be turned into a factory that would process raw materials into useful products. Even more grandiose, however, is a scheme proposed by Georg von Tiesenhausen and Wesley Darbro of the Marshall Space Flight Center. They have borrowed ideas from the famous mathematician John von Neumann; according to this proposal, the Moon base would turn out parts that would automatically make new factories exactly the same as the base from which they had evolved. In other words, the Moon would be the site of mankind's first self-replicating factories.

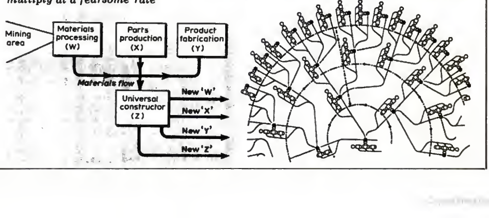
In 1952, von Neumann, a Hungarian-American mathematician who had already given the world several hugely useful guidelines on how to build and apply electronic computers, started work on a book on automata. It was provisionally titled *The Theory of Automata Construction, Reproduction, Homogeneity*. The book was never finished. After the great man died in 1957, Arthur Burks, a colleague, edited the manuscript, added fresh material and, on the basis of this, in 1966 published the *Theory of Self-Reproducing Automota*. Several engineers have, meanwhile, developed von Neumann's ideas further—among them the pair from NASA.

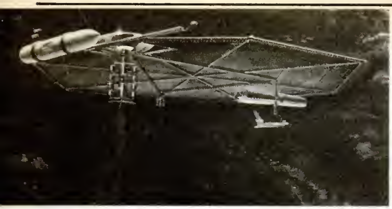
Von Neumann postulated that a self-reproducing automoton must have four components. Component *A* is an automatic factory that collects raw materials and turns them into products according to a written instruction. Component *B* is a duplicator, which takes the set of instructions and copies it. Component *C* is a controller, linked to both *A* and *B*. When *C* is given an instruction it first passes it to *B* for duplication, then to *A* for action, and finally supplies the copied instruction to the parts that *A* produces. Component *D* is a written instruction which contains the specification that lets *A* manufacture the complete system—*A* plus *B* and *C*.

In July last year, von Tiesenhausen and his colleague produced an engineering blueprint for a Moon factory built according to von Neumann's theory *(Self-Replicating Systems—A Systems Engineering Approach, NASA Technical Memorandum 78304)*. The facility would have four main components. The first three are a processing unit, which would mine materials from the surrounding area and process them; a production system that makes sub-assemblies from materials fed to it from the processing unit; and an assembly facility (see diagram, bottom left).

These three components are each stocked with robots, advanced machine tools and computers that turn out parts according to instructions. The fourth part of the Moon factory is what is called the universal constructor. This is the most crucial piece of equipment. It takes parts from the third of the components—the assembly facility—and with them turns out complete new factories. The new plants would, of course, contain their own universal constructors. So the process begins over again and the factories reproduce at an exponential rate. The first factory constructed on the Moon would, according to the theory, take one year to produce an offspring. After a decade, there would be about 1000 of the plants—and 1000 million after 30 years. Von Tiesenhausen, assistant director of advanced systems at the Huntsville centre, says that engineers would want to stop the factories reproducing before this point—otherwise they would run out of space. But he says the concept provides a good way of expanding output from the Moon with only minimal engineering effort. □

Factories that reproduce could be a feature of the Moon. Parts from one factory make components for another (bottom, left) and (right) ensure that workshops multiply at a fearsome rate





Boeing

A huge plant in the sky could produce useful material from lunar soil (right) only a slightly less ambitious scheme from NASA for a space operations centre

materials to places much further away in space.

We know enough about lunar materials to be able to define a range of physical, chemical and thermal techniques that could transform the Moon's soil to useful products. In the early stages, engineers will adapt techniques used in the Earth's workshops. Similarly, reagents and equipment will initially come from Earth: later, Moon workers will get virtually all their materials from the Moon itself.

Several criteria must be met when choosing manufacturing methods for use in space. For instance, they should use solar energy and local materials as far as possible; they should be suitable for automation (few people will want to work in space and it will be expensive to keep them there); and the techniques should be versatile enough to produce a wide range of products with little waste.

Last year, a NASA-sponsored workshop at the University of Santa Clara studied 220 manufacturing methods used on Earth to see how many could be adapted for space factories. The study identified 35 technologies that could be used on the Moon with only a little adaptation. The list includes techniques based on casting, moulding, welding and machining (the latter using lasers and electron beams).

Some of the Earth's well established manufacturing methods would be useless on the Moon. In a vacuum, and in the absence of a protective layer on their surfaces, materials adhere to each other very easily. This process is known as "cold welding". Hence many orthodox machining methods which involve metal-to-metal contact would be unsuitable: engineers would find that cutting tools contaminate or even stick to the materials they are fashioning.

But other, less orthodox techniques, which take into account the peculiar conditions on the Moon, look highly promising. Engineers could separate lunar soils into oxygen, metals and oxides using what is called the hydrofluoric-acid leach process. In this, the acid is added to Moon dust. Silica separates as silicon fluoride and metals such as calcium, aluminium, iron, magnesium and titanium are recovered by reducing (with materials such as sodium) their fluoride derivatives. Researchers at Rockwell International in Downey, California and at the California Space Institute in San Diego are testing the technique. The leach process requires a small amount of plant, uses relatively little energy and produces a range of useful materials.

Researchers have proposed a prototype plant based on the process. It would require a massive 500 m by 500 m solar array to provide energy and could process 30 000 tonnes of lunar soil per year (top, left). Initially, engineers would have to bring from Earth about 63 tonnes of hydrogen, fluorine and sodium to provide some of the raw materials. Thereafter, these materials could be recovered from the plant's products. The installation could be operated by just 20 people.

Another promising separation technique is electrophoresis, which takes advantage of the fine grains found in lunar soil. An electric field is applied to a mixture of lunar soil and a fluid suspension medium such as water or, possibly, basaltic slag. The different electrostatic potentials of the minerals in the soil cause them to separate.

The raw materials would have to be combined in predetermined mixtures to make useful products. What is called powder-materials processing could be useful here—a technique that embraces both powder metallurgy, when metals are involved, and sintering, which applies to ceramics.

Powder metallurgy is a forming and fabrication technique that comprises three stages. The raw material is first divided into many small particles. This powder is then injected into a mould or passed through a die to form a weakly cohesive structure (called a green compact) that takes up something like the shape required in the final product. Finally, the product is formed by applying pressure or temperature or being allowed to set for a long time.

People on Earth have been using powder metallurgy since 1200 BC. But two factors make it look promising in Moon factories. First, in space the surfaces of powdered materials remain in pristine condition for a long time; there is very little to contaminate them. Thus, thanks to the process of cold welding, the particles will adhere well to each other to give large masses of pure material. Secondly, reduced gravity ensures that well-mixed grains can adhere to each other in a random manner and not settle out as on Earth. The "green compact" will contain fewer voids: unfilled space would take up as little as 1 per cent of the total volume of the material. The comparable figure in compacts made on Earth is 10 to 30 per cent. The lower porosity achievable in space should produce strong, dense materials without the need for high pressures and temperatures in the forming stage of the process.

Sintering is the process of fusing moulded clays into ceramics. Once again, the starting material must be powdered. The particles are then compressed with a binder (a suitable chemical that makes the material stick together) to produce a dough-like material that can be shaped to form products. On Earth, these shaped clay forms cannot be very big, otherwise they slump and distort under gravity; in space, this is much less of a problem. After shaping (by extrusion or cutting), the clay form can be heated to produce a hardened product. Tholentic basalt, a material that is abundant in lunar soils, could have many applications on the Moon. It can be cast, sintered, or spun to produce tiles, pipes or very fine fibres. The material's strength and modulus of elasticity compares favourably with those of iron, carbon steels and other metal alloys.

A small factory, called a "starting kit" and based on powder-metallurgy technology, could operate on the Moon. Bars of solid metal are fed into a furnace into which solar energy is focused. The bars are rotated so that, as their ends melt, droplets of material spin off to the sides of the furnace. The rate of powder production can be adjusted in several ways—by changing the size of the bars, the rate of heating or the speed of rotation. From the sides of the furnace, the powder is directed to a collection port where it is separated into different sizes, for instance by electrostatic methods or vibration.

Suitable sizes of particles, perhaps representing different materials, proceed to an ejector which directs them onto a surface: this will eventually form part of the product being manufactured. The beam is continually swept across the surface to gradually build up the part. A system of dies and rollers shapes the material in the desired way. Finally, the product is taken to an inspection station where TV cameras record dimensions, while lasers or electron beams provide a final trim, or drill holes. Robots and other automated systems handle the solid pieces of metal and direct them to other parts of the factory where, for instance, they are bolted together or otherwise made into finished goods. A great range of useful products could be made virtually completely from the materials found on the Moon (Table 2).

NASA is spending £10 million per year on research to discover ways of producing materials in space. Experiments on board Spacelab should help engineers to find out more about what can be ultimately achieved in space factories (Box B).

Initially, factories on the Moon would make products for use there and for deeper in space. The products of the lunar plants would form parts of space platforms, that orbit either around the Earth or the Moon. Eventually, as production increases and costs go down, some goods would be sent to Earth. And as industrial and human operations in space expand, it would be relatively easy to adapt industrial techniques to missions much further from the Earth. For instance, people could deflect asteroids that cross both the orbits of Earth and Mars, build factories on them and use them for comfortable travel to the outer reaches of the Solar System. Similarly, engineers could construct plants on the moons of Mars to provide the equipment for that planet's exploration.

If men and women are ever to explore anything of the Universe beyond the near reaches of space, it is hardly likely that they will be able to obtain their supplies from Earth. Factories far out in space will provide them with the goods they need. That is why, if people are to take seriously the idea of space travel, the industrialisation of space becomes a major priority. ☐

Table 2. Useful products from the Moon

Structural materials

- Metals—steels, aluminium, magnesium, titanium
- Reinforced metals—aluminium and magnesium, alloys of Fe, Al, Mg and Ti, or metals reinforced with silica, steel or alumina
- Glasses, fused silica
- Ceramics, alumina, magnesia, silica, compounds
- Hydraulic cements

Electrical materials

- Conductors—aluminium, magnesium, iron
- Electrodes—graphite
- Magnetic materials, iron alloys, ceramics, glass

Fibrous materials

Glass, silica

Plastics, elastomers and sealants

Soluble silicates, silicone resins

Adhesives and coatings

Anodised aluminium, magnesium, titanium, electroplating, sputtered cortings etc

Lubricants, heat transfer fluids, propellants

Sulphides, sulphur dioxide, helium, oxygen, silanes

Industrial chemicals

Detergents, cleansers, solvents, acids, bases, H_2SO_4, H_3PO_4, CaO, NaOH

B. Cuts threaten US's efforts in space manufacturing

Budget cuts have badly hit NASA's programme of experiments to prepare for the processing of materials in space. Consequently, plans for turning out products in space factories are starting to slip behind schedule.

Louis Testardi, NASA's director of materials processing, admits that "budget constraints are a problem". He also says that the delays in getting the space shuttle airborne have led to two other areas of difficulty. First, opportunities for flying experiments on the shuttle over the next few years will be fewer than expected. Secondly, the delays have frustrated some researchers, who have left the programme. "Good people do not like staying on during postponements," observes Testardi.

Frustration was behind the abrupt departure from NASA earlier this year of John Carruthers, Testardi's predecessor. Carruthers had grandiose plans for a comprehensive series of materials-science experiments during the 1980s, supported by research into robots, machine intelligence and automated systems that would do many of the jobs in space factories. Carruthers's timetable called for the construction of fully operating space plants during the decade after 2010.

Hit by demands for cuts from the Reagan administration, NASA was unable, however, to give Carruthers the cash he needed to start his programme. This year the administration is spending $18 million on research into materials processing, compared with some $20 million three years ago. Taking into account inflation, this adds up to a substantial decrease in resources. Embittered, Carruthers left for a job with industry.

Testardi, formerly a solid-state physicist at Bell Laboratories, points out that experiments in space require years of preparation in laboratories on the ground. Earth-based experiments account for most of the cash that NASA is spending on materials processing. But the number of projects that NASA is funding in this area—investigations into growing crystals in zero gravity, for instance—has fallen in three years from 100 to 30. The decrease is due both to the budget cuts and to the fact that—as shuttle flights start to loom up—more cash is diverted from work in laboratories to expensive hardware for space flights.

The shuttle is due to take into orbit, over the next four years, six packages containing materials-science experiments. The packages, which each weigh almost a tonne and contain their own computers and recording instruments, will stay in the craft's payload bay as it orbits the Earth. The shuttle will also take into space several smaller packs of experiments, which are stowed in lockers in the vehicle's crew room. Further, NASA's third Spacelab flight, in 1985, will carry several materials science experiments.

Faced with a government determined to reduce public spending, NASA hopes that private enterprise will provide cash for future projects. Already NASA has concluded one agreement for a joint venture in space. Among the experiments that it will take into orbit next year are several provided by McDonnell Douglas which, with Johnson & Johnson, wants to test ways of making pharmaceuticals. The two firms are particularly interested in electrophoresis, a process in which materials separate from solutions under the influence of an electric field: for some kind of solutions, zero gravity promises to speed up the process considerably. If initial results are good, the companies say they could start commercial space plants by 1986.

NASA is talking to two other firms about similar deals. Microgravity Research Associates is interested in growing gallium arsenside crystals; and GTI Inc wants to run a "space furnace" to make new kinds of materials. If making things in space appears profitable, firms such as these may be willing to contribute some of the cost of large orbiting plants that space planners think could be a feature of the next decade. ☐

NEI

Interim results for the half year ended 30th June 1981

Profit up 20%
Turnover up 22%
UK Exports £110 million
Record order book
Increased dividend

"The NEI results for the half year demonstrate the Company's ability to continue its growth even during a time of recession.

I believe that with our strong order book, our sound financial base and our ability to serve a broad range of industries, NEI prospects remain favourable for the rest of this year and beyond."

Duncan McDonald CBE, Chairman

	HALF YEAR ENDED 30.6.81	HALF YEAR ENDED 30.6.80	YEAR ENDED 31.12.80
TURNOVER	**£331 million**	£272 million	£610 million
PROFIT BEFORE TAXATION	**£15.058 million**	£12.548 million	£26.064 million
PROFIT attributable to NEI Shareholders (after taxation and extraordinary items)	**£8.729 million**	£7.696 million	£16.204 million
EARNINGS PER ORDINARY SHARE—Net basis	**5.11p**	4.96p	10.51p
DIVIDEND PER ORDINARY SHARE	**1.375p**	1.25p	3.75p

Copies of the report are available from the Company Secretary, Northern Engineering Industries Ltd., NEI House, Regent Centre, Newcastle upon Tyne, NE3 3SB.

Northern Engineering Industries Ltd.

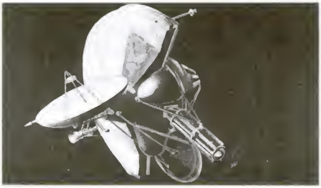
Machines uncover the secrets of space

Many schemes are afoot to discover more about the outer planets with unmanned "robot" explorers. All the planners need is the cash to pay for them

Dr Christine Sutton Scientists and engineers the world over are planning a series of unmanned missions to explore further the Solar System. The proposed flights would study the outer planets, Pluto in particular; visit the asteroids, the rocky lumps that orbit the Sun mainly between the orbits of Mars and Jupiter; and collect samples from Mars to return to Earth.

Exploration of the Solar System—as opposed to observation—by unmanned spacecraft began in January 1959 when the USSR sent Luna 1 to within 6000 km of the Moon. Later in the same year, Luna 2 crash-landed on the Moon, and thus began a spate of missions that has taken robot spacecraft to orbit, land or merely fly past the innermost five of the eight planets (other than the Earth) that inhabit the Solar System.

Over the next eight years another two planets should join this list. NASA's Voyager 2 will visit Uranus and Neptune after a journey that has already taken it close to Jupiter and Saturn and which, by 1989, will have lasted 12 years.



The Galileo probe (the cone-shaped object on the right) will descend through Jupiter's atmosphere

Voyager 2 and its sister spacecraft, Voyager 1, in 1979 revealed much new information about Jupiter and its moons. They discovered active volcanoes on Io (the inner of the four largest moons) and a narrow ring around the planet. Now NASA's only approved venture in planetary exploration is for a mission called Galileo that will return to Jupiter six years from now.

The venture involves two spacecraft; one will orbit Jupiter, taking pictures of the planet and its moons, for about 20 months. The other will descend into the planet's colourful but cold and hostile atmosphere of hydrogen and helium. The two spacecraft will be launched from separate flights of the space shuttle in 1984—two years later than once planned. The probe will carry instruments to sample and analyse the constituents of Jupiter's atmosphere—the first sampling of any of the outer "gas giants". It will travel to Jupiter on a carrier spacecraft which will release the probe to enter the atmosphere within a few degrees of the planet's equator. As the probe descends it will transmit data to the carrier spacecraft which will in turn relay the data to Earth. A parachute will slow down the probe's descent so that it should transmit for 60-90 minutes until the increasing temperature and pressure stop it working.

The European Space Agency will conduct its first interplanetary mission in 1986, when the spacecraft Giotto encounters Halley's comet. Launched by the agency's Ariane rocket, Giotto will meet up with Halley's comet four weeks after its closest approach to the Sun. The spacecraft will come within 1000 km of the comet's icy nucleus, which is only a few kilometres across, and will sample the huge envelope of hydrogen and other gases that gives the comet its spectacular appearance.

Japan and the Soviet Union also plan to send spacecraft to Halley's comet; France is joining forces with the USSR in its venture to send two spacecraft first to investigate Venus, and then to orbit the Sun on the way to the comet. NASA, meanwhile, has no approved plans to join in this once-in-a-lifetime experience—Halley's comet returns to the inner Solar System once every 76 years. However, one group at NASA's Jet Propulsion Laboratory in Pasadena is studying several options for a mission to the comet, the most exciting being one designed to return to Earth, carrying samples of the comet's "atmosphere".

To minimise costs and risks to a tight schedule—the launch has to be in 1985—designs need to be based on existing spacecraft, such as those used in Galileo. The spacecraft would come within about 3000 km of the comet's nucleus to pick up samples in the coma—the material that "boils off" the nucleus as it warms up when the comet passes closest to the Sun.

Mars is another body that is to the fore of the minds of scientists, both in the US and Europe. European scientists are studying a proposal to send a spacecraft to orbit Mars, after a launch in 1988 or 1990. The proposers of the mission, code-named Kepler, believe that there are still many unanswered questions about the red planet. Kepler would carry 10 instruments to investigate the Martian atmosphere; how the planet interacts with the solar wind (the stream of energetic electrons and protons from the Sun); what sort of magnetic field, if any, the planet has; and the planet's topography.

NASA's studies for future missions to Mars vary from orbiting spacecraft, which would obtain radar maps of the planet's surface, to attempts to bring samples from the planet back to Earth. The USSR brought back material from the Moon in 1970, using an unmanned spacecraft, Luna 16. The probe collected 101 grams of lunar soil and then set off back for Earth. NASA is also studying how to drop onto Mars from an orbiting spacecraft robust devices called "penetrators" which carry several instruments. The devices would embed themselves in the Martian surface, and provide measurements at many locations other than the two points at which NASA's Viking landers came to rest in 1976.

In a yet more glamorous option, NASA would send to Mars small gliding aircraft, controlled by computers, that could carry cameras and other instruments across the hills and valleys. And there is still the idea to drop a Mars rover on the planet—a vehicle with artificial intelligence that could roam the planet as the Soviet Lunokhods did on the Moon in the early 1970s.

NASA's ideas for the future do not stop at Mars. There are schemes to send more spacecraft to Saturn, in the wake of the Voyager spacecrafts' amazing discoveries about this planet over the past year. Scientists would like to learn more about Titan, Saturn's largest moon, whose surface is hidden from view by a thick nitrogen atmosphere. A spacecraft orbiting Saturn, carrying a radar instrument, would be able to "see" through the clouds and map the moon's surface; another possibility would be to drop a probe into the atmosphere, perhaps to land on the surface. Other schemes for the outer planets are to send a spacecraft to fly by Pluto, and to search the Solar System beyond Pluto—although such plans would require new methods of propulsion if the missions are not to take an inordinately long time. □

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Satellites show their warlike face

Most of the satellites put into space have been for the world's military forces. The superpowers are keeping track of each other's movements with an ever more advanced battery of spies in the sky

Future conflicts may well be called not world wars, but space wars . . .

Lucas Film

Mark Hewish

Space has been described as the battlefield of the future. This is not strictly true: war is already being waged in space, in a cat-and-mouse game played by the superpowers. The era of space battleships armed with lasers and particle-beam weapons is many years in the future. But military chiefs are surprisingly well practised in using a more prosaic kind of spacecraft—satellites—mainly for surveillance. Of the 3000 or so satellites launched so far, about two-thirds have either been entirely military or have fed information into defence projects. Last year alone, the USSR placed in orbit at least 85 military satellites.

As far back as the late 1940s, the US thought about using satellites as high-flying robot spies to complement or even replace manned aircraft. In the 1950s, engineers from both the US and the USSR developed ballistic missiles that flew in space on their way to targets. The engineers quickly gained expertise in the technology of large rockets, guidance electronics and re-entry vehicles—the latter to protect warheads as they plummet into the atmosphere at many thousand kilometres per hour. Replace the warhead with a spacecraft, use miniature re-entry vehicles to carry film back to Earth, and you have a "spy satellite."

The very technology that made spies in the sky possible also provided the reason for developing more of them. Both superpowers wanted to know the exact locations of the targets for their missiles. And they were desperate to find out about the other side's rocketry developments: satellites could provide both types of information.

The skies are now criss-crossed with a web of surveillance satellites operated by military forces. The vehicles carry film and televison cameras, infrared sensors that can see at night, radars to penetrate cloud and bad weather, and listening devices to intercept "enemy" radar and radio transmissions. The space vehicles are also used in other areas of warfare. In the 1960s, when the US Navy launched its first submarines carrying Polaris ballistic missiles, naval engineers needed to tell the vessels' commanders where their targets were. The original guidance information would become outdated after many weeks at sea. The answer was the network of Transit navigation satellites that is still widely used today.

At about the same time, the commanders of air bases and aircraft carriers wanted to know what the weather would be like over targets to be attacked by their aircraft—so a new breed of military meteorological satellites was born. A large part of the radio traffic between NATO commanders and their forces is now routed via specialised communications satellites. Other spacecraft watch for a nuclear attacks, monitor enemy missile tests and measure the effectiveness of new weapons.

Before the 1980s are out, American soldiers in their foxholes in Europe will be able to find out where they are (to within a few metres) by tuning in to a web of 18 NavStar navigation satellites that fly in shoals more than 16 000 km above their heads. They will be able to communicate directly from a bunker in Germany to their headquarters in Washington DC—simply by unstrapping a satellite terminal that is small enough to be carried on a man's back. Surveillance spacecraft hovering in geostationary orbit at a height of 36 000 km will stare at the Earth with perhaps a million or more individual infrared detectors, looking for the slight rise in temperature that shows up a cruise missile's jet-engine exhaust.

In the days of the Cold War, the Americans in particular had good reason to develop spy satellites. To find out about the US's ballistic missiles, the Soviet Union had only to peruse government documents freely available in Washington, buy good maps of the US and instruct spies to look out for major earthworks. For the US, it was not so easy. No Westerners were allowed anywhere near Russian missile bases, and Soviet maps deliberately showed big towns and other potential targets up to 15 km away from their true positions.

A significant event took place in August 1960—though at the time it seemed prosaic enough. A US Air Force satellite called Discoverer 13 ejected a capsule containing photographic film; the capsule re-entered the atmosphere and was picked up from the sea. This exercise showed that pictures could be taken in space and returned to Earth for analysis. This method is still used today when military officials need high-quality photographs from satellites.

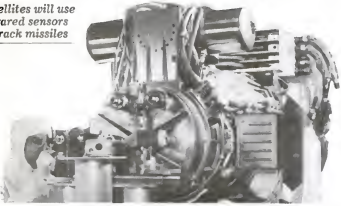
In parallel, American scientists developed a way of obtaining photos more quickly. The film is automatically processed inside the spacecraft and the prints scanned by a narrow light beam passing back and forth across it. The various shades of grey are converted to radio signals and transmitted to Earth, where a similar arrangement in reverse builds up prints with the characteristic lined appearance of wire photos.

In January 1961, the US launched Samos 2, its first operational surveillance satellite that relied on radio transmission. The craft orbited the globe for a month. By mid-1972, a total of 109 US spacecraft had systematically mapped most areas of military interest on the Earth's surface. They have since been succeeded by the aptly named Big Birds—huge 13-tonne reconnaissance satellites—and by the KH-11 craft. The latter are operated by the Central Intelligence Agency rather than the US Air Force.

The KH-11 has a life in orbit of two years or more, compared with five or six months for Big Bird. It sends its pictures back to Earth via a digital data link rather than in film capsules. Engineers can manoeuvre their satellite out of its normal orbit to take a more detailed look at areas in which they are particularly interested—the war zone in the recent fighting between Iran and Iraq for instance.

The US Air Force still has a small number of its earlier close-look satellites, known as low-altitude surveillance platforms, which it keeps in reserve for emergencies. The most recent one was launched on 28 February, when the build-up of Russian forces near the Polish border was reaching its peak. These craft fly relatively close to the Earth—as near as 130 km. So they fall into the planet's atmosphere and burn up after the short time of 50 to 80 days. The cameras on these space vehicles can distinguish objects only 15 cm in diameter. The film is ejected in capsules and snatched in mid-air by C-130 Hercules aircraft.

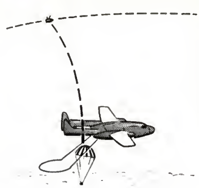
The space shuttle will play a big part in military surveillance. The US Air Force has only three of the low-altitude surveillance satellites in reserve and will run out of Big Birds in 1983. A new version of the KH-11 providing better-quality pictures will be launched in 1984, but in the future the only way of getting high-resolution pictures back to Earth will be to carry cameras in the shuttle. By placing their faith in manned space vehicles for spying from the sky, the US's military chiefs are returning to a concept which their country once abandoned: Big Bird was assigned high priority only because the Air Force's planned manned orbiting laboratory (MOL), was cancelled in 1969. The laboratory, based on the two-man Gemini capsules that NASA placed in orbit during the 1960s, would have been used for surveillance missions.



Satellites will use infrared sensors to track missiles

Targets will obviously have to be extremely important to risk flying a manned (and very expensive) shuttle over them to take photographs in times of tension. This is especially true once the Soviet Union has perfected its killer satellites—unmanned craft that manoeuvre alongside orbiting vehicles and blow them up with explosives.

In the late 1980s, American armed forces will concentrate on radar rather than cameras for space surveillance. One type of satellite will track the movements of Warsaw Pact tanks and other armoured vehicles, while the US Navy will use another to watch for warships. The Navy already has its own ocean-surveillance system: this comprises sets of three satellites which fly in clusters on parallel paths. The craft use interferometry techniques: they compute ships' positions from data provided by several antennas which measure the direction from which vessels' radar or radio signals arrive.



A quick film service: military aircraft routinely pluck from the sky film capsules which are ejected from orbiting spy satellites. In another technique, the satellite transmits data to the ground while it is zooming over the Earth and taking pictures

In its space surveillance activities, the USSR concentrates on satellites that return film to Earth. Last year the Soviet Union launched 35 such craft, of which 7 provided pictures of the Earth for peaceful uses—to find out information about geology or the growth of crops for instance. The rest had military applications. Four of the vehicles were of a recent design. Bigger than most satellites, they are similar to the Soyuz vehicles that ferry crew to and from the Salyut space stations. The Soyuz-type reconnaissance satellites carry solar cells to provide electrical power, giving them twice the two-week life of earlier battery-powered types. At least three Russian satellites of different types observed the early days of the Iran-Iraq war last September.

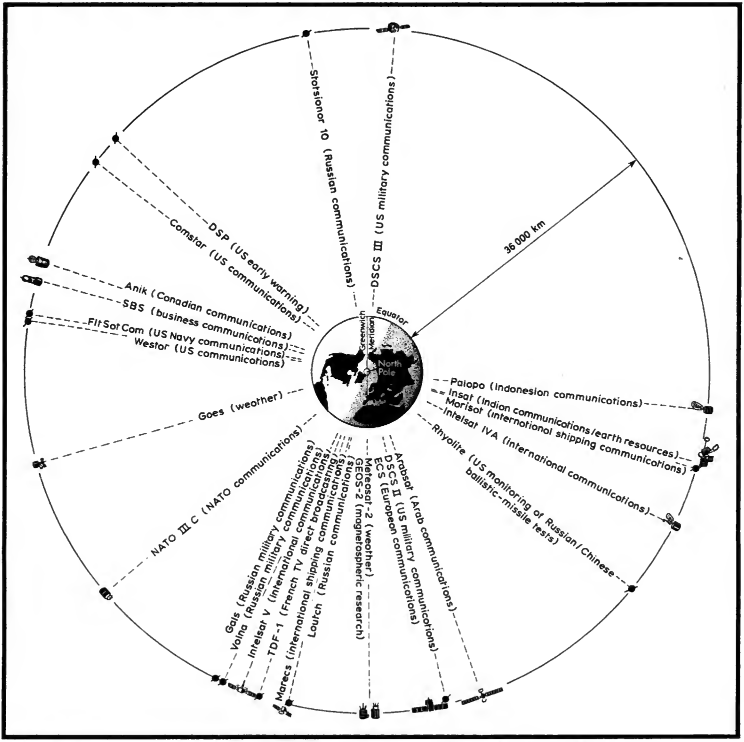
A military base in space

Military crews aboard NASA spacecraft have brought back information useful for defence purposes, but Russia has pioneered manned missions devoted specifically to military operations. The third and fifth Salyut space stations, launched in 1974 and 1976, carried high-resolution cameras in place of scientific instruments and flew slightly lower than their civilian counterparts. There have been no purely military Salyuts recently, however, so their role may have been taken over by unmanned craft. Both the US and Russia are looking at permanent space stations carrying up to 12 men at a time, and these will have obvious military applications.

The Russians, like the Americans, have specialised in satellites that look solely at the oceans. One of these, Cosmos 954, crashed in Canada in January 1978 and scattered radioactive debris from its nuclear power generator. One of the three Russian sea-surveillance satellites launched last year had similar characteristics to Cosmos 954, but the other two were "ferrets" that listen to radio transmissions. If photo-reconnaissance satellites are the eyes of a modern intelligence service, then the ferrets are its ears. The craft eavesdrop on enemy communications, record them on tape and then replay the messages as the satellites pass over their own ground stations. The US Air Force normally orbits ferrets in piggyback fashion, using the same booster rocket as a Big Bird or KH-11. Last year the Russians launched six of these craft.

One of the US's earliest military space projects was Midas, a network of satellites in low orbits (a few hundred kilometres above the Earth) which were designed to give 30 minutes' warning of a Russian missile attack. This would double the warning time provided by a chain of three

Satellites speed the world's information flow . . . .


Statsionar 10 (Russian communications)
DSCS III (US military communications)
36 000 km
DSP (US early warning)
Comstar (US communications)
Anik (Canadian communications)
SBS (business communications)
FltSatCom (US Navy communications)
Westar (US communications)
Greenwich Meridian
Equator
North Pole
Palapa (Indonesian communications)
Insat (Indian communications/earth resources)
Marisat (international shipping communications)
Intelsat IVA (international communications)
Rhyolite (US monitoring of Russian/Chinese ballistic-missile tests)
Goes (weather)
NATO III C (NATO communications)
Gals (Russian military communications)
Volna (Russian military communications)
Intelsat V (international communications)
TDF-1 (French TV direct broadcasting)
Marecs (international shipping communications)
Loutch (Russian communications)
Meteosat-2 (weather)
GEOS-2 (magnetospheric research)
Arabsat (Arab communications)
DSCS II (US military communications)
ECS (European communications)

Satellites are jostling for space in geostationary orbit, particularly in the most sought-after positions over the Atlantic

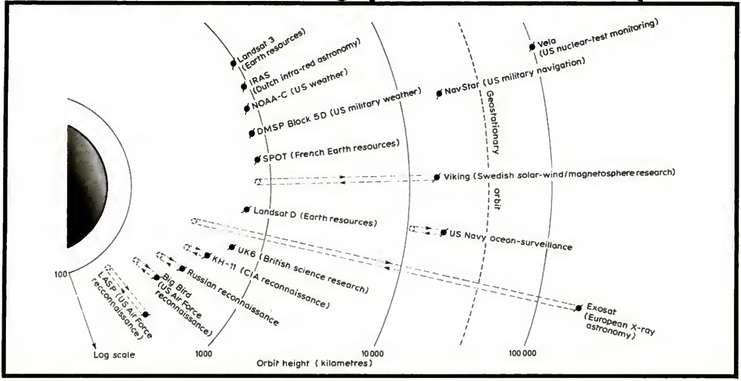
ground-based radars, one of which is at Fylingdales in Yorkshire. (The others are in Alaska and Greenland.) Midas satellites carried infrared sensors to detect the heat given off by the engines of Soviet missiles—but unfortunately they have failed to work. In 1972, therefore, the US Air Force switched its emphasis to satellites in geostationary orbit with what it calls the Defence Support Program.

One of the satellites in the project is positioned over the Indian Ocean, where it can monitor missile tests in China and the Soviet Union and also warn of an attack on the US by land-based missiles. Another hovers over central America, alerting the US if submarines fire missiles. Replacement satellites are launched as the old ones wear out.

The satellites each carry about 2000 infrared sensors that detect radiation with wavelengths between 3 and 5 micrometres—the type of electromagnetic waves given off by very hot objects such as missile engines. The next generation of early-warning satellites will probably operate between 8 and 13 micrometres. They will be able to detect cooler objects, the jet engines of aircraft for instance.

In 1984, in an experiment code-named Teal Ruby, the US Air Force plans to launch its P80-1 research satellite with an unusual passenger on board—an array of 150 000 infrared detectors. If the experiment is successful, the US may launch another satellite called HALO (high altitude, large optics) which will carry up to 10 million detectors. In

. . . . but are turning space into a rubbish tip


Landsat 3 (Earth resources)
IRAS (Dutch infra-red astronomy)
NOAA-C (US weather)
DMSP Block 5D (US military weather)
SPOT (French Earth resources)
Landsat D (Earth resources)
UK6 (British science research)
KH-11 (CIA reconnaissance)
Russian reconnaissance
Big Bird (US Air Force reconnaissance)
LASP (US Air Force reconnaissance)
Vela (US nuclear-test monitoring)
NavStar (US military navigation)
Geostationary orbit
Viking (Swedish solar-wind/magnetosphere research)
US Navy ocean-surveillance
Exosat (European X-ray astronomy)
100
1000
10 000
100 000
Log scale
Orbit height (kilometres)

Low-Earth orbits are primarily the domain of military and scientific satellites

The lumps of metal that make up the satellite world

Satellites can be broadly divided into two types. The first travels in a geostationary orbit around the equator at a height of 36 000 km; the second type takes up other available orbits. In a geostationary position, a space vehicle completes one sweep around the Earth in the same time that the planet makes one rotation. It thus appears to hover motionless in the sky. A satellite in geostationary orbit can "see" about one-third of the Earth's surface, so it can relay radio and data messages and TV programmes between any two points in that area.

Most communication satellites, such as those in the Intelsat series used by more than 100 countries, are in geostationary orbit—as is a network of weather satellites provided by agencies in the United States, Europe, USSR and Japan. The US has several military satellites in this orbit, in what it calls the Defence Support Program. These craft should warn of attacks by ballistic missiles. With its Rhyolite craft, America also monitors tests of these weapons by Russia and China.

More than 170 communications satellites are already in the geostationary position or are planned. Add all the military satellites, together with those now planned for direct broadcasting of television programmes, and the space left for more satellites in this orbit becomes very limited. International agreements ensure that the signals from satellites near each other are modified so that they do not cause interference.

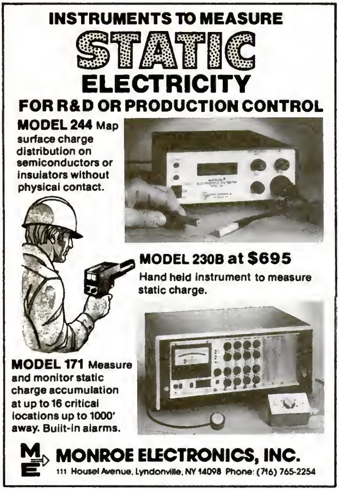
Space nearer the Earth is also very crowded, with 3000 or so satellites jostling for position alongside bits of old rockets and other debris. The vastness of space makes collisions unlikely, but one day the shuttle may have to act as a garbage truck to retrieve space junk or nudge it into a different orbit so that it re-enters the atmosphere and burns up. The band of space from the top of the Earth's atmosphere (70 or so km high) to a height of several hundred kilometres is occupied by satellites that have to get as close a view as possible of what is going on beneath them. Several types of spy satellite fly very low, brushing through the highest point of the atmosphere, as their instruments strain to pick out the smallest details. As a result, their orbits "decay" very quickly and they may have lives of only a few weeks. Further up are the longer-lived civilian Earth-resources satellites, doing a similar job but accepting a correspondingly inferior picture quality. At roughly the same heights are the civilian and military low-orbit weather satellites, which have orbits that take them over the poles.

Scientific research satellites frequently have orbits that bring them near the Earth at their perigee but fling them out into the depths of space at apogee. This shape of orbit may be adopted for various reasons; it helps, for instance, in the examination of the magnetosphere. ☐

conventional early-warning satellites, the view of the Earth is scanned across the array of detectors to build up a picture. In Teal Ruby, however, the detectors "stare" continuously at the scene, just like a frog's eye. This change is expected to improve the sensitivity by a factor of five and allows information from the sensors to be updated several times a second. As the rocket engines of an intermediate-range ballistic missile burn for only 30 to 50 seconds, the staring array gives a much better chance of detection.

Satellites also play a part in military communications. The US, Soviet Union, NATO and Britain have all launched this kind of craft. The vehicles operate similarly to satellites such as the Intelsat series used for ordinary international telephone calls. The military vehicles transmit to and from terminals on land, ships and aircraft. The US Air Force, which needs to link people who operate nuclear bombers, missile control centres and early-warning networks, has an unusual approach: it puts its transponders on other people's satellites. The Air Force's AFSatCom system includes 12 channels on each of the US Navy's FltSatCom satellites, with other transponders on commercial spacecraft. AFSatCom may use up to 30 transponders on host satellites by the late 1980s.

A new generation of military satellites is on the way, however, which incorporates technology substantially differ-



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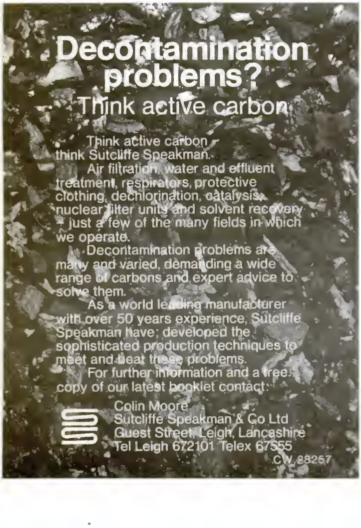

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ent from that in its commercial counterparts. General Electric is building a satellite called DSCS III. The electronic circuitry in the craft is shielded to withstand nuclear radiation, and jamming its communications links is much more difficult. If a ground-based jammer locks on to one of the radio channels, the channel shuts down and is replaced by another one with different characteristics.

A major problem with radio links is their limited capacity. And the "footprint" on the ground—the area over which the radio energy is spread—may approach 500 km in diameter for a geostationary satellite, giving weak signals. So military engineers in the US are experimenting with laser communications. A laser could send information between ground stations via a satellite at the rate of 1000 million bits per second—equivalent to transmitting the contents of the Encyclopedia Britannica every second—yet produce a footprint only a few hundred metres across. Such transmissions would be almost impossible to intercept or jam. Last December, the Air Force completed Earth-bound trials with an experimental laser system and will launch it on the P80-1 satellite in about 1984.

Military commanders also need to know where they are: hence the reason for navigation satellites. The Transit network of navigation satellites operated by the US Navy since the mid-1960s continues to be used by mariners throughout the world, and has recently been updated by the introduction of three new satellites known as Novas. The satellites transmit radio signals on a precise schedule that is corrected as they fly over timing stations on the ground. Receivers on board ships detect the doppler shift—the slight change in frequency of the radio signals as the relative positions and speeds of the vessels and satellites alter—and a computer works out the ship's position to within 200 m or so.

In the mid-1980s this arrangement will be replaced by the Global Positioning System, using 18 NavStar satellites orbiting in belts at a height of more than 16 000 km. Each spacecraft will carry three atomic clocks accurate to one second in 30 years. Receivers in land vehicles, backpacks, ships, aircraft and even missiles will measure the time that radio signals arrive from different satellites. As the transmission times of the signals are coordinated, the receiver can calculate its own position and speed. The network has been reduced from 24 satellites to 18 to save money, but it will still be accurate to within about 16 m. With the system, missiles will be able to fly to unseen distant targets (so long as the exact location of that target is known). Landing craft will be able to approach strange beaches in complete darkness. Even squads of soldiers out on patrol will be able to work out their precise position. If there is another World War, satellites—normally thought of as perfectly benign examples of spacecraft—will play a big part in influencing its course. ☐

Walt Disney

Alan Adler

Prometheus bounded ?

Genes, mind and culture

by C. J. Lumsden and E. O. Wilson, *Harvard UP, pp 428, £12*

Cultural transmission and evolution

by L. L. Cavalli-Sforza and M. W. Feldman

Princeton UP, pp 388, £14, ppb £5·90

An interviewer for a Warsaw radio station stopped a citizen in the street. Was the recent demonstration necessary? "History will tell." But what did *he* think? "I am not a historian." Likewise Lumsden's and Wilson's book. If it is not a load of codswallop, it will turn out to be very important. If it is not a load of codswallop. *Faites vos jeux!*

Wilson's previous books, *Sociobiology* and *On Human Nature*, have earned him a Pulitzer Prize and a jug of water poured over his head at a scientific meeting (followed by a speech from Garland Allen in justification). The substantial opinion of most anthropologists, sociologists, Marxists and ordinary thinking persons is that there is no such thing as human nature: that in Simone de Beauvoir's words we are the being whose essence is to have no nature. That is to say that at some stage in our evolution our brains were selected to lose all innate behaviour patterns and to have an infinite capacity to learn any behaviour presented to us by our culture. Man therefore is to be understood purely as the outcome of his cultural environment, not at all of his genes, except in the sense that we all carry the set of genes which liberated us from our genes. In challenging this view, Wilson is taking on a majority of the intellectual establishment, and the jug of water signified that within the tribe he was to be regarded as a witch, someone to whom the normal manners and morality do not apply.

Richard Dawkins in *The Selfish Gene* suggested that cultural change could be modelled by examining the rules by which cultural artefacts of any kind (a philosophical idea, a stone axe or a marriage custom) were propagated from person to person. The survival of the artefact would depend not only on its success in being transmitted but on its success, or failure, at keeping its bearers alive and reproducing.

At the time the idea was rather original, and somewhat derided. In *Cultural Transmission and Evolution*, Cavalli-Sforza and Feldman have made a superb job of modelling this notion mathematically, fully acknowledging both the strength (rigour) and weakness (simplification) of describing the real, complicated world in equations. Yet Dawkins is cited only in an aside: his book was a popularisation, and it gave off the wrong philosophical vibes (many people must have been disturbed by the sense that we might be "nothing more" than the bearers of DNA: God one can love or reject but what can one feel one way or the other for an immortal coil of sugar phosphate?).

On Human Nature revealed Wilson's view of mankind as less hard at the centre than Dawkins's, and warmer. With Charles Lumsden, a young theoretician, he now explores the consequences of partly rejecting the doctrine that "culture maketh man", which they dub "environmental determinism", a neatly humourous turning about of the charge that Wilson's thought was spearheading a politically nasty movement called "genetic determinism". The idea that we are in a state, to be understood only holistically, in which we make our culture, which makes us, requires the very special hypothesis that Wilson and Lumsden call "the Promethean gene", about human evolution. It is held that long ago and far away the special development of our brains along with our social institutions, selected the gene complex which released the brain from the functioning of the other genes, and made cultural evolution occur of itself and by itself.

Empirical evidence on this point is rare, just as rhetoric and pretty scenarios are common. But *Genes, Mind and Culture* produces what may be a very powerful argument: even if such a *tabula rasa* organism arises, it is not evolutionarily stable and will evolve into one with a tendency to innate preferences. The theorem is simple: at any time in history the possession of certain stone axes, marriage customs or safety belts will confer greater chances of survival or reproduction. Any gene mutation causing its possessor to adopt that artefact more than the common run is favoured by natural selection and will establish itself in the species. This argument is so important that it would have been good to see a much greater exploration of the conditions under which it holds.

It is clearly not always true: a society which changed its "rules" in every generation ("don't do what the elders do, do what they *say*") and rewarded conformers with larger families would seem likely to select for a *tabula rasa*. But as societies are seldom like this, then Lumsden and Wilson are formally correct and we cannot look at cultural evolution as a self-contained process: culture and the human genome will *co-evolve*, in a continuing cycle in which the evolution of one drives the evolution of the other. (I must point out here that Wilson's view is *not* the "genetic determinism" which holds that we are controlled entirely by our genes, but simply that given the choice of learning a number of behaviour patterns we may be innately prone to learn one rather than another, other things being equal.)

This inevitably raises two questions, whose answers are critical to the thesis. First, there is the question of relative speed: once the brain has reached a sufficient degree of complexity, might not the speed of cultural change be so great that biological evolution would be totally unable to keep up? This would amount to the Promethean hypothesis again. Wilson and Lumsden adduce two arguments against it: the empirical observation that most cultures are rather conservative (here we have to forget our own, highly atypical technological society: our species spent nearly all its history in tribal societies whose marked cultural conservatism is explained, according to Cavalli-Sforza and Feldman's modelling, by the almost exclusive transmission of culture by parents rather than "teachers" or mass communicators), and that given strong enough selection, genetic change can take place rather rapidly.

Ingram Pinn

The second question, the answer to which affects the answer to the first, is the kind of gene action involved. What sort of genes will be selected by cultural practices? We can dismiss as trivial blood groups and other biochemical traits, for although cultural practices will indeed select them (by affecting disease transmission, for instance), these genes will have little effect on culture. We may laugh at the notion that there could be genes "for monogamy", but this is not what is argued by the authors. They suggest instead that the genes involved are those which control the development of the brain, and hence operate a series of cognitive and preferential emotional filters.

More of our behaviour than we like to think is controlled by the structure of our central nervous system. An impressive array of evidence from perceptual and behavioural psychology is quoted to show, for instance, that we have innate propensities to perceive colours as belonging to three broad classes (and to name them accordingly, the most convincing case in the book of a direct developmental influence on that most human cultural item, our language), to fear spiders, snakes, thunderstorms and strangers who stare at us, to eschew copulating with our sibs and, for women, to form strong emotional bonds with our infants in the few hours after birth (the nearest thing we do to "imprinting") and to cradle them with their heads to the left. This is a long way from the genetics of female puberty rites but at least it makes a case for genetically influenced behaviour not being an empty set.

To the argument that once cultural change becomes rapid enough, genetic change should be left too far behind to be a significant part of the system, Lumsden and Wilson have two, weaker, answers: the first is the "leash" principle, which seems to be that large cultural changes will sooner or later trigger the spread of a mutation which responds to them, thus partly besmirching whatever has developed of a *tabula rasa* and starting the coevolutionary cycle over again. However, the leash on which our genes hold our culture might be a long one: the authors imply that our technological society changes too fast for us to adapt to it biologically, leaving us to respond as best we can with behaviours, such as tribal xenophobia, which however adaptive they were in the neolithic are a disaster now we have the Bomb. The Opposition will give Wilson a mallet on *both* his big toes for this last suggestion: a hint that he likes the idea of our having these primitive responses partly built in, and he is a red-necked fascist; if he doesn't like it, he's a goddam pessimist! Cavalli-Sforza and Feldman are cannier. They keep off warfare. The examples they quote of non-adaptive cultural traits that have spread against all genetic sense are smoking, alcohol, birth control and ritual mutilation.

What say Cavalli-Sforza and Feldman about Prometheus and his leash? Tantalisingly, nothing. As population geneticists, they are fully equipped to deal with the problem of relative rates, and half a dozen times their book is heading full tilt for the genetic question: every time they refuse the fence. It is not that they refute the idea of Prometheus bounded. They just act as if the thought could not be thought. The nearest they get is the observation that cultural evolution differentiates tribes very much faster than genetic evolution: African populations with very similar blood group distributions build houses of quite different shapes. We have the not uncommon phenomenon that it is the outsider, Wilson the non-geneticist, who boldly brings genetics into the argument, where the better-qualified fear to tread.

But to be fair, Cavalli-Sforza and Feldman promise to tackle this question in a second volume. I hope they plunge right in. Their analysis is rational and beautifully argued with examples, so that despite the much greater amount of mathematics their book is by far the easier to read. Wilson's style, so finely suited to broad, humanistic essays like *Human nature*, gives the impression in tight theoretical arguments that he is using something he tells us the human mind is good at, "fuzzy logic". If anyone's analysis is going to be correct, it will be that of Cavalli-Sforza and Feldman. Provided, that is, that they can stare out the tribal shamans who proclaim the great taboos. **John Turner**

Dr John R. G. Turner is Reader in Evolutionary Genetics at the University of Leeds

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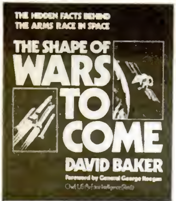

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REVIEW

The doomsday book of animals

by David Day

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After man

by Dougal Dixon

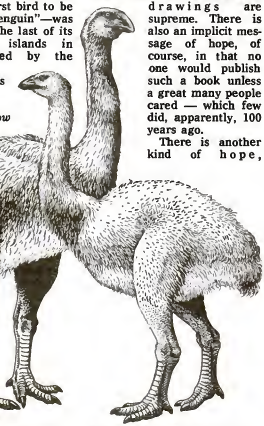
Granada, pp 124, £8·95

The astonishing thing about the giant moa, *Dinornis maximus*, is not that it was such an outlandish beast, but that it survived almost to within living memory. It was not the world's heaviest bird; at 275 kg it was only half the weight of the unrelated *Aepyornis maximus*, of Madagascar. But it was by far the tallest—four metres, against *Aepyornis*'s three. The giant moa was the greatest of about 25 species of flightless birds of the family *Dinorthinidae* ("terrible birds") which for tens of millions of years dominated New Zealand, filling the niches that in other lands were generally pre-empted by mammals.

The *Dinorthinidae* first confronted man in the 10th century AD, when the Maoris arrived. They hung on until modern times but by 1850 the entire family was extinct.

The fate of *D. maximus* provides one of the most poignant case-histories among the 300 extinctions taking place, over a mere three centuries, that David Day describes in his outstanding *The Doomsday Book of Animals*. After all, there is a small compensation for the loss of the Pennsylvanian bison (*Bison bison pennsylvanicus*), extinct in 1825; or the Oregon bison (*B. b. oreganus*) which became extinct in 1850—for some forms of American bison still exist. The delicately marked Bali tiger (*Panthera tigris balica*) which died out only in 1937 is a great loss, but the other seven subspecies are at least hanging on by a thread. The *Dinornithidae* were not mere variations on a theme but an alternative life form which showed briefly that neither the mammals nor the dinosaurs had any predestined claim to world domination. A flightless bird, too, could be a formidable beast.

The passing of the *Dinornithidae* illustrates, too, the fallacy that "primitive" man necessarily lived at peace with nature. The mammals of the Pleistocene probably owe their extinction largely to stone-age man; and the Moas died largely to satisfy the pride of the Maoris. But in more modern times human beings have eliminated animals out of sheer cupidity. Thus the Great Auk (*Alca* (*Pinguinus*) *impennis*)—the first bird to be called a "penguin"—was eliminated from the last of its North Atlantic islands in 1844: slaughtered by the million, year after year until extinction, for its feathers. The pots that boiled the water that softened the corpses to release the feathers were fuelled by fat from the birds themselves.



The moas Dinornis maximus *and* Pachyornis septentrionalis, *now long extinct*

The passenger pigeon, *Ectopistes migratorius* is the world's most spectacular extinction. At one time that single species accounted for 40 per cent of all North American birds. In 1813 James Audubon observed a flock in Louisville that took three days to fly past, blotting out the Sun. A single flock could be 500 km long and contain two thousand million birds. Perhaps it was their destructiveness in that new agricultural country that launched the wave of slaughter; but the trainloads of hunters and the truckloads of corpses that traversed the US in the mid 19th century seem to reflect collective predatory madness. It simply should not have been possible to eliminate such a species; but the last one died in the wild in 1900.

The Doomsday Book of Animals is of course a catalogue of gloom but it is much more than that. Instead of anger and rhetoric David Day writes natural history of rare quality, and the paintings and drawings are supreme. There is also an implicit message of hope, of course, in that no one would publish such a book unless a great many people cared — which few did, apparently, 100 years ago.

There is another kind of hope, albeit of a bizarre and gothic quality. It is that extinction is the common end of all species; but whatever disappears is replaced. In *After Man*, Dougal Dixon asks what kind of creatures—mainly mammals and birds—would evolve within 50 million years if we disappeared (which is certainly possible) and if we took the more vulnerable and dependent species with us (as is certainly plausible). The results (again marvellously illustrated) are extraordinary; but Dixon is a zoologist and palaeontologist, who understands the constraints that shape animals, and knows that no creature can be more bizarre than those that nature has at some time produced.

Thus, animal forms must conform to survival strategies and engineering principles: convergent evolution reflects the attempts of unrelated animals to solve the same problems. Today we have herons, stock still on stilt-like legs, shooting out their heads like spears to catch fish, while maintaining perfect balance.

There is no mammalian equivalent, but why not? Dixon envisages the Reedstilt, descended from today's insectivores—four stilt-like legs instead of the heron's two; and a pointed snout.

The loss of Africa's vulnerable big cats would leave a niche for new predators. Why not descendents of the baboon—already predatory, and a survivor if ever there was one? Given its present shape—heavy hind-quarters and supple body—could it not re-invoke the predatory form of *Tyrannosaurus rex*—bipedal, and with tremendous mobility of body, pivoted around the hips and balanced by a heavy tail? Hence Dixon invents the formidable Raboon. With the whales gone, what will soak up the krill? Answer, perhaps, the Vortex, giant descendent of the penguin, its beak an exact parallel of the baleen whales' whalebone oral seives. Where land mammals had disappeared, might bats again come down to earth—there are many comparable precedents in nature—and if they did, what form might they take? The appalling, blind Night Stalker, perhaps, running on fore-limbs that once were wings, and bringing its great clawed hind limbs over its shoulders.

Dixon's book is marvellous fantasy. It is also excellent zoology from which any student could learn basic principles of evolutionary anatomy. His and Day's books are labours of love, and each is a masterpiece. **Colin Tudge**

The horrific Night-Stalker

The expanding circle: ethics and sociobiology

by Peter Singer

Oxford UP, pp 173, £6·95

Rather varied opinions have been expressed about the bearing of sociobiology on ethics. Its most famous exponent, Edward O. Wilson, has claimed that it should simply take over the whole topic, because it can "explain ethics at all depths" and "make possible the selection of a more deeply understood and enduring code of moral values". Radical critics, by contrast, have denounced the whole enterprise as both unscientific and immoral. It seems very lucky that Peter Singer, an uncommonly clear-headed moral philosopher accustomed to large problems, is here to put aside both exaggerations and get the topic in perspective.

Singer promptly gets rid of one confusion which has misled some of the critics. As he says, what sociobiology offers is "not an evolutionary ethics in the standard sense". It does not claim, as social Darwinist theories do, that "the course of evolution is itself good", and can reveal the aims and standards of conduct. What then does it offer? Wilson defines it simply as "the systematic study of the biological basis of all social behaviour". This sounds harmless enough. But applied to man it causes alarm, because to study such a biological basis involves using arguments from natural selection.

Opponents commonly do not deny that selection took place, but they tend to see any particular argument drawn from it as threateningly fatalistic. Sophisticated resistance to these arguments, therefore, now tends to take the form of general scepticism about our knowledge of the mechanisms of evolution. This scarcely meets the point. Sociobiologists probably are indeed too confident in their detailed calculations, and at times wildly over-simple in their views on genetics. But this does not get rid of selection. Selection certainly has been at work, and it is the only evolutionary force so far suggested which is at all intelligible.

As Singer says, the bearing on ethics is indirect, through our conception of human nature. On a very crude view,

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selection seems to demand that we should be pure egoists. This would have real moral consequences, as much of ethics would in that case be meaningless to us. But then this crude view has given way to the theory of kin selection. Evolution, it seems, ensures that no social animal is a pure egoist, not even ourselves.

But how far can altruism intelligibly go? As Singer says, sociobiologists have been strangely timid about the obvious extension of altruism beyond kin. They tend to talk as if, at a deeper level, egoism were always the real explanation. This not only accounts for a lot of their unpopularity. but also wastes one of their best insights—the perception that ambivalence, marking real conflicts of interests, is a fundamental feature of our nature. There are vast problems here. In his admirable little book, Singer concentrates on what is certainly the central point—rationality. He sees our intellectual nature as inevitably demanding that the privileges granted to those near us, such as kin, be gradually extended to others like them, and so is bound to lead—unless we avoid thinking—to universalising morals. This seems very good moral as well as sociobiological sense. It is not the whole answer, but it certainly points the right way. Can peace be declared?

Mary Midgely

Mary Midgely is a senior lecturer in the Department of Philosophy at the University of Newcastle upon Tyne.

An introduction to behavioural ecology

by J. Krebs and N. Davies

Blackwell Scientific, pp 292,

£18, ppb £7·50

Behavioural ecology is essentially a functional approach to animal behaviour. It questions how an animal's behaviour is adapted to its environment.

This is the second book which the authors have produced on behavioural ecology and it takes many examples from the earlier one (*Behavioural Ecology: an Evolutionary Approach*, 1978). However, although a lot of material is duplicated, the new book provides a more structured and coherent appraisal than the previous text, which was a multi-authored collection of papers.

The authors have aimed *An Introduction to Behavioural Ecology* at 2nd and 3rd year undergraduates and they hope to have "presented (their) ideas in simple but precise language". Their style of writing is certainly colloquial and in some places, downright racy. The descriptions of "gang bangs" in wrasse and of bees as "flying penises", will raise some eyebrows, but I am sure this colourful use of language will appeal to the majority of readers.

The book begins by discussing the action of natural selection on behaviour and inevitably relies heavily on the recent evolutionary theories presented in E. O. Wilson's *Sociobiology* and Richard Dawkins' *The Selfish Gene*. It then proceeds to consider the approaches used to study the adaptiveness of behaviour.

The book does not provide many new insights, but theoretical aspects are clearly described and the examples are, as the authors would say, bang up to date. The layout and production of the book are good, and more detailed, mathematical theories are put in boxes which may be skipped by a casual reader. The only problems such a reader may have are in negotiating the elaborate system of sub-headings. I found myself frequently looking back to check if I was reading a sub-section of a chapter sub-section, or a sub-section, of a sub-section, of a sub-section.

Some of the functional explanations put forward in the book will certainly have their critics, especially as many of the examples are based on optimality models which have been described as "panglossian just-so stories". The authors anticipate this criticism in the final chapter and stress that optimality models do not test the idea that animals are optimally adapted, but indicate what function they are maximising in the short term.

This book fills a useful niche in the behaviour literature. It is pitched at just the right level for an undergraduate textbook; I would recommend it highly. **Richard Cowie**

Dr Richad Cowie is in the Department of Zoology at University College Cardiff.

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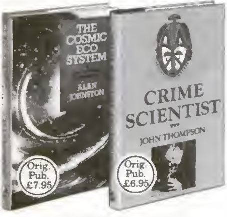

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Bookwatch

Science in China: Pandora's box or Aladdin's lamp?

During the past three or four years there have been major changes in the progress of science in China. In the same period several scientific journals have proliferated, and these provide an insight into both government policy on science and the direction of scientific development.

Since the fall of the "Gang of Four" in 1977, the Chinese development programme has been based on the so-called Four Modernisations. These are in the fields of defence, agriculture, industry and science and technology. The modernisation of science and technology involves the importing of Western research and development, sending students abroad, and inviting Western scientists to lecture in China. The ambitious scientific programme is supported by the China Academy of Science, a highly centralised government body. It is the academy which has promoted, both directly and indirectly, the rapid growth of scientific periodicals.

In addition to the increasing numbers of academic periodicals edited by universities and research institutions, there are more than 60 popularised scientific journals which are published regularly. While some of these are revived versions of periodicals which were interrupted by the Cultural Revolution in 1966, most are newly established.

These journals fall into three categories:

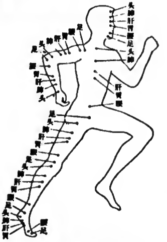
1. Those for children and young teenagers, such as *Children's Science Pictorial*, *Juvenile Science*, *Middle School Science and Technology* and *We Love Science*.
2. Those for teenagers and laypeople, such as *Modernisation*, *Ship Knowledge*, *Science Pictorial*, *Scientific Experiments*, *Public Medicine*, *Electronic World* and *Knowledge is Power*.
3. Those for intellectuals and interdisciplinary studies, such as *Nature Journal*, the Chinese editions of *Scientific American* and *Science 81*, *Teaching Physics*, *Economic Management*, *Social Science Front*, *Science and Philosophy*, *Impact of Science on Society* (Chinese edition), *Journal of the Dialectics of Nature* and *World Science Translation*.

Since September 1979, the Chinese edition of *Scientific American* has been published by the Chong-Qing branch of the Science and Technology Literature Publisher, and edited by the Chong-Qing branch of the Chinese Science and Technological Information Research Institute. This body obtained full permission for translation from *Scientific American's* publisher, and one or two pages are usually reserved for advertisements.

The translations are of a high standard, indicating the importance placed upon the publication. One important factor leading to the decision to publish *Scientific American* was the recommendation made to the authorities by several leading Chinese scientists living in the US, including the Nobel prize-winning physicist Dr C. N. Young.

Other journals containing translated articles are edited and published by translation bureaux based in Peking, Shanghai, Canton and other major cities. Again the standard of translation is high. It seems that every current scientific periodical published in industrial countries (including *New Scientist*) is collected, and the articles are selected carefully before translation.

During the Cultural Revolution, the articles were selected according to rigid ideological criteria; but recently many subjects which would then have been forbidden have appeared without editorial comment. Several of the newly-published periodicals imitate in style and content magazines published in other countries. One of these is *Nature Journal*, which in title and layout is similar to the British *Nature*. In this monthly magazine, established in 1978 by Shanghai Science and Technology Publisher, discussion of scientific theories in the West predominates. However, in every issue there are reports on more specifically Chinese research, for example on the special inductive function of the human body, parapsychological power and psychobody energy (a form of mental control over the body). The journal has also examined historical evidence of Chinese scientific discoveries which had been ignored before 1949, and somewhat distorted during the Cultural Revolution.



From an article on "The Bio-Holographic Law" which appeared in Nature Journal *this year*

The *Journal of the Dialectics of Nature* has as its subtitle "a comprehensive theoretical journal of the philosophy, history and sociology of natural science". It was founded in 1979, edited and published by the Journal of the Dialectics of Nature Publisher which is administered by the China Academy of Science. Its first editorial explained that the journal sets out to relate natural science, social science, history and philosophy, and that it should follow the tradition of Marxist-Leninism and Maoism and be directed by the dialectics of nature and "combative historical materialism".

The dialectics of nature is considered a most essential part of Marxist-Leninist philosophy of nature, and has been introduced into the teaching of science in most Communist countries. In China, all the phenomena of nature as well as scientific theories are interpreted in terms of the dialectics of nature; scientists, technicians and readers alike are expected to be guided by this "universally valid theory". It is therefore not surprising that for decades China has had little interest in joining the international activities of the philosophy of science, mainly because the Chinese authorities had decided that current Western philosophy of science was dominated by "bourgeois capitalist idealist values".

However, there are signs that the present authority is adopting a more flexible attitude towards this philosophy. Since the *Journal of the Dialectics of Nature* was started, several leading Chinese scientists have broken their decades' long silence. At first the issue was mentioned implicitly or through metaphors, but gradually more explicit voices of dissent have been increasing. As the style and editorial policy of the journal shifted, criticisms which had at first been expressed only in letters became the subject of formal articles. In two recent issues there are articles questioning the authoritarian dialectics of nature as well as re-evaluating the party's science policy.

The boom in scientific periodicals, of which we have dealt with three in detail, seems to reflect the desire on the part of the Chinese authorities to provide every possible means to fill the 10 years' gap in scientific education. The education of all Chinese at schools and universities between the years of 1966 and 1976 was entirely dominated by the Cultural Revolution, during which schools were closed frequently, certain subjects were not taught, teaching staff were often changed and there was very little information from overseas. There is now concern that a lack of appropriately educated people, particularly scientists and technicians, would be one of the main obstacles to the Four Modernisations. The popular science journals are a means to recover the lapse.

The success of these journals will depend on an effective nationwide library system, a high percentage of educated people at the grass-roots level, and the availability of time and money; these conditions are themselves dependent on the current modernisation programme. But at the same time the journals may introduce new ideas into a massive and until recently, relatively closed society, effectively opening windows which had hitherto been closed. It remains to be seen whether the journals will be an Aladdin's lamp or a Pandora's box for the Chinese people and the authorities.

C. R. Forest
Helen Crane

C. R. Forest is an engineer with a special interest in the development of science and technology in China.

REVIEW

The physicists

by C. P. Snow

Macmillan, pp 192, £8·95

The combination of C. P. Snow's name and the glossy format will sell this book. The text is slight, for over 70 pages comprise photographs (mostly well known) and diagrams (good and helpful). It is the first draft, completed from memory "straight off and at great speed" just before Snow's death, of a book he intended to write at great length. This makes it a badge of courage as well as a *tour de force* but it is offered as much more. The jacket blurb says that "like nothing else in literature it gives one the feeling of how creative science really happens . . . it opens a new world for the general non-scientific reader"; it paints "a vivid picture of the interplay of personalities and politics"; it restages "the drama of the Manhattan project with its cast of bumbling bureaucrats, disbelieving generals and euphoric refugee scientists" etc.

Ernest Rutherford, Mark Oliphant, C. P. Snow, Albert Einstein

Sam Waagenaar/Camera Press

Lawrence Mynott Cambridge UP

The Physicists is presented "as a literary work" but it will be accepted as history which, like science, requires meticulous use of evidence. Yet Cooper's introduction, while acknowledging the fallibility of memory, asserts that "when an artist calls upon memory what he writes has a life and a moving quality which scarcely ever infuses the product of the filing cabinet which we nowadays refer to as researched information". In dealing with such momentous history is "research"—search for the truth—to be a dirty word?

In this uncorrected first draft large and small discrepancies between memory and fact appear in many places. Peter Kapitsa was not "the only member of Rutherford's scientific entourage who understood him well"—James Chadwick and Mark Oliphant certainly did.

Some of the most important mistakes are in the events of 1939 and the war years. The book rightly reproduces Snow's own very prescient editorial about a possible atomic bomb in *Discovery* in September 1939 and his subjective recollections about his own consultations at that time would have been valuable. As it is, he omits entirely from an ostensibly objective account the work, and priority in discovery, of Frédéric Joliot-Curie's team in Paris in 1939 (which has had long-term political consequences); he puts the date of the Bohr-Wheeler paper which explained the theory of uranium fission as early summer 1939 when in fact it appeared two days before war broke out; he barely mentions the crucial British Maud Committee whose 1941 report pushed the American project off the ground; he dates the actual Manhattan project as 1940 not 1942; he says Franklin D. Roosevelt and Winston Churchill discussed Niels Bohr at a Quebec, not Hyde Park, Conference, he says General Groves's security system worked badly although, extraordinarily enough, the Germans knew nothing about the $2000 million project until the bombs fell (even though the Russians did).

Mistakes of fact are accompanied by misjudgments: for example that Groves was a "singularly bad choice for his job". Most of the scientists in the project, however much they may have disliked him, believed he was essential to its success. I have checked with Sir Mark Oliphant that the

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statement (p 120) that at the end of the war he was "demanding that England and his own Australia should make the bomb themselves" is the exact opposite of the truth. Since this is an emotive issue in Australia it could also be damaging.

Apart from such confusions, even the use of words such as "the golden age" of "pure science" can be misleading without qualification. Hans Bethe after all spoke of his life in Germany in the 1920s as unsatisfactory "in every respect except work" with many of his colleagues and professors "terrible chauvinists" while Enrico Fermi and his colleagues, and Joliot-Curie and *his* colleagues had quickly taken out patents on their work in 1934 and 1939 respectively. The very interpretation of "the physicists" is limited in the book: the highly important work in solid state and low temperature physics is not mentioned.

I regret my emphasis on these shortcomings but having found that people who studied Snow's novel *The New Men* for GCE English take it as the real story of the atomic bomb I fear *The Physicists* too will become a standard text of popular history. To publish this first draft without any editing is no tribute to Snow. If he had lived he would surely have checked his memory as well as expanded his thought. **Margaret Gowing**

Professor Margaret Gowing is Professor of the History of Science at Oxford University, and co-author of *The Atomic Bomb* (Butterworths, 1979).

From *The New Solar System*

Halley's comet in 1910—Venus is also in view

Orbiting the Sun
by Fred L. Whipple
Harvard UP, pp 338, £14
The new solar system
edited by J. K. Beatty,
B. O'Leary and A. Chaikin
Cambridge UP, pp 224 £9·95

Many planetary scientists involved in the exploration of our Solar System by spacecraft did not start their careers in astronomy, but were involved in various aspects of Earth science, and only turned their interest to other bodies in the Solar System when data from spacecraft become available. Before then, the Solar System was almost entirely the domain of the astronomer. To learn about the previous astronomical observations of the planets many non-astronomers turned to Fred Whipple's introductory text *Earth, Moon and Planets*.

His new book *Orbiting the Sun* is essentially an updated version in which he has replaced earlier observations with new observations from spacecraft. The first seven chapters are a basic introduction to the astronomy of the Solar System and as such provide the reader with some of the basic foundations of astronomy and the associated scientific principles. The topics covered include planetary orbits, determining planetary masses and the history of observation. The planets and satellites are then dealt with in a classical way, treating each as a separate body, and the book concludes with chapters on planetary comparisons and the origin and evolution of the Solar System.

Generally the presentation is very much that of an astronomer although Whipple describes new observations in the fields of geology, geophysics and atmospheric science, and he keeps a good balance between the dramatic new discoveries and the older astronomical observations. Thus the Moon is illustrated, not only by the most recent Apollo photographs, but also by those taken from earlier space missions as well as by Earth-based telescopes. The reader is therefore aware of a continuum of studies from the early astronomical work to the most recent.

Whipple's highly readable style makes this an excellent book for anyone wanting to learn about the Solar System without any previous knowledge of the subject.

The New Solar System is quite different in style and as soon as one flips through the book the numerous beautiful illustrations give an intense visual impact of the rapid development of planetary science since the 1960s. As the editors explain in their preface, the aim is to produce a book which lies halfway between a textbook and a "coffee table" volume. They have successfully achieved this—as well as being visually attractive it is hugely informative.

They do not take a classical view, but emphasise instead the new era of exploration, and treat the subject in a series of topics that ranges from descriptions of specific planetary missions, to chapters about impact cratering, planetary atmospheres, surface geology and life on Mars. Each of the chapters is written by an outstanding expert.

Despite the multidisciplinary and multi-authored nature of the book, there is an overall conformity in the format and style, each topic being well explained and easy to read without being simplistic. The authors have made good use of illustrations, a high percentage of which are in colour, and have taken care to choose pictures and diagrams that have not been published in other books. Particularly valuable are the beautifully redrawn diagrams that have only appeared in scientific journals, and the artists' impressions of unusual views in the Solar System.

I strongly recommend the book to keen amateurs, first year university students interested in astronomy and Solar System science and, indeed, anyone excited by space exploration; many astronomers and Earth scientists will want to read it to catch up on those areas of the science that they are not specifically concerned with. At the end of the book, one is left with the feeling that although exciting leaps forward in knowledge have been made, we are only at the beginning of our understanding of the Solar System in which we live. **John Guest**

Dr John Guest is in the Department of Physics and Astronomy at University College London.

A History of Computing in the Twentieth Century

edited by N. Metropolis, J. Howlett and Gian-Carlo Rota

February 1981, 688pp., £19·60 (UK only)/$29·50, 0.12.491650.3

From the reviews

"Complementing more than a dozen contributions on the development of these early electromagnetic and electronic dinosaurs . . . are other papers on the early development of languages and programming. But perhaps most fascinating of all are the contributions that deal with the people (such as Alan Turing, and John Von Neumann) and the places involved . . . providing an insight into an epoch of revolutionary intellectual ferment and technical advance, and a flavour not only of the hardware . . . but also of its social relations . . . What makes this book different is that it is a history written by the actors themselves—and for that reason it will remain an important source of reference as well as an illuminating and enjoyable read." **Richard Clarke in New Scientist**

Computers and People Series

Recent Advances in Personal Construct Technology

edited by Mildred L. G. Shaw

July 1981, xii + 232pp., £12·00 (UK only)/$29·00, 0.12.639260.9

In the last five years there has been a great upsurge of interest in George Kelly's personal contruct theory, which has been used to explain how similar events can be interpreted very differently by different people. *Recent Advances in Personal Construct Technology* is based on a special issue of the International Journal of Man-Machine Studies on personal construct technology, published in July 1980, together with three related papers from the Journal and a new introductory chapter.

The European Transition from Oil

Societal Impacts and Constraints on Energy Policy

edited by Gordon T. Goodman, Lars Kristoferson and Jack M. Hollander

September 1981, xvi + 338pp., £20·60 (UK only)/$49·50, 0.12.290420.6

The dramatic price increases in imported oil during the 1970s and the more recent political volatility in the Middle East have raised anxieties in Europe about alternative energy policies if, in the future, we are forced away from oil. This book maps out the main technical, environmental, socio-economic, institutional and political problems and their interactions, which might accompany such a transition.

Genetic Engineering 2

edited by Robert Williamson

July 1981, xii + 204pp., £9·80 (UK only)/$24·00, 0.12.270302.2

"The Academic Press volumes, however, are streets ahead of any other genetic engineering series. Genetic Engineering 2, *like its predecessor, is brilliant but easy to read—a winning combination. A. J. Jeffreys has written a masterly review on recent discoveries about gene evolution, with fascinating comments on pseudogenes and other evolutionary relics. R. A. Flavell, F. G. Grosveld and H. H. Dahl take up half the book with a complete rundown on all aspects of building up a genomic library, or "genotheque". Two brief chapters round off the volume: J. D. Beggs has written an introductory account of the new art of cloning in yeasts, and restriction enzymes—hammer and chisel of the genetic engineer—are covered in a succinct piece by A. D. B. Malcolm. At the price they are, these slim red books deserve to be on the shelf of any genetic engineer worth his DNA."*

John Humphreys in New Scientist

Genetic Consequences of Man Made Change

edited by J. A. Bishop and L. M. Cook

September/October 1981, xiv + 410pp., £23·60 (UK only)/$57·00, 0.12.101620.x

Contents

Contributors. Foreword. Preface. **J. A. Bishop and L. M. Cook:** Genes, phenotype and environment. **J. A. Bishop:** A NeoDarwinian approach to resistance: examples from mammals. **R. J. Wood:** Insecticide resistance: genes and mechanisms. **R. J. Wood and J. A. Bishop:** Insecticide resistance: populations and evolution. **D. R. Lees:** Industrial melanism: genetic adaptation of animals to air pollution. **M. R. Machnair:** Tolerance of higher plants to toxic materials. **J. A. Barrett:** The evolutionary consequences of monoculture. **J. R. Saunders:** Human impact on microbial evolution. **R. J. White and R. M. White:** Some numerical methods for the study of genetic changes. Index.

History of Botanical Science

An account of the development of botany from ancient times to the present day

A. G. Morton

September/October 1981, xii + 474pp.
Hardback: £18·80 (UK only)/$45·50, 0.12.508380.7
Paperback: £8·80 (UK only)/$21·50, 0.12.508382.3

Professor Morton's book describes the development of scientfic thought about plants from its origins to the present day. It is the fruit of years of careful study and reassessment of the principal primary sources, ancient and modern, bringing forward much new or neglected material to give fresh insight into many aspects of botanical progress. Written in a lucid style, with the minimum of technical language, the work is accessible to readers with a general interest in science as well as to professional botanists.

Energy Science and Engineering Resources, Technology, Management. An International Series

Fuel and Energy

J. H. Harker and J. R. Backhurst

June 1981, xii + 362pp.
Hardback: £21·00 (UK only)/$50·50, 0.12.325250.4
Paperback: £8·80 (UK only)/$21·50, 0.12.325252.0

The book, which draws heavily on an earlier volume, *Fuel Science* (Harker & Allen, 1972), aims to show that there has been a considerable change in emphasis in recent years, so that fuel science has expanded into the more general energy studies. Energy sources and resources are discussed, and a major part of the book is devoted to the production of properties and utilization of primary and secondary fuels. Different sections consider energy conversion with combustible and other energy conversion processes, including nuclear energy, wind, water and solar power. The final chapter deals with the economics of energy use and the costs involved in energy conversion.

Reliability and Risk Analysis

Methods and Nuclear Power Applications

Norman J. McCormick

September 1981, 446pp., £26·20 (UK only)/$39·50, 0.12.482360.2

This volume provides an introduction to the fundamentals of, and principal results that can be expected from, reliability and risk studies for nuclear power applications. The book is aimed at postgraduate students interested in methods of analysis and at both professionals and students who want a detailed summary of the risks to society of nuclear power systems. Also included is a comparison of nuclear and non-nuclear risks, results of some studies and a discussion of the public acceptance of risk.

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REVIEW

Putt's law and the successful technocrat

by Archibald Putt

Exposition, pp 165, $9·25

Recent research has shown that Parkinson's Law, the Peter Principle, and even Potter's theories of Gamesmanship and Lifemanship are "inadequate and misleading when applied to fields dominated by technology".

Fortunately, thanks to many years of intensive research by Dr Archibald Putt, these deficiencies in our understanding of technocratic organisational dynamics and psycho-sociology have been remedied. The results are described in Putt's recently-published and scholarly treatise, *Putt's Law and the Successful Technocrat.*

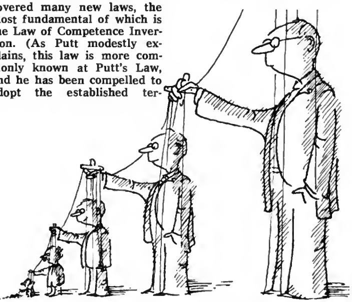
Putt's research has uncovered many new laws, the most fundamental of which is the Law of Competence Inversion. (As Putt modestly explains, this law is more commonly known at Putt's Law, and he has been compelled to adopt the established terminology in order to avoid confusion in the literature.) Putt's Law states: "Every technical hierarchy, in time, develops a competence inversion."

The corollary, less pithy but more descriptive, is that technology is dominated by two types of people: those who understand what they do not manage, and those who manage what they do not understand.

Putt's Law, far from being regrettable, describes a highly-desirable state of affairs in which "incompetence is flushed out of the lower levels, leaving competent people behind to do the work. Putt's Law can be regarded as the prime reason for the continued success of technology even in the face of an ever-growing bureaucracy."

Putt's study, academic and scholarly as it is, is not without practical guidelines for the progressive technocrat (in this context progressive must be interpreted as "wanting to get on career-wise"). For example, the Law of Failure—"Technology abhors little failures, but rewards big ones", has the corollary, "If you must fail, fail big". The First Law of Advice states that "The correct advice to give is the advice that is desired." And "When in doubt, form a task force; when doubt persists, form a committee." (Fourth Law of Advice).

That latest and most *terrible* of technological infants, the data processing industry, has not escaped Putt's scholarly scrutiny. To whit, "All systems and software projects take longer than estimated" (DP Supplier's Law). He has also uncovered several parallels with Murphy's Law—one of which is "Anything that can go wrong will go wrong faster with a computer".



Rencin

This fascinating addition to the P-literature (Parkinson, Peter, Potter, Putt) is undoubtedly a major contribution to our understanding of Western Technological Man. The characters Putt introduces in his case-histories—Dr I. M. Sharp, Roger Proofsworthy *et al*—will surely become as well-known as Rollo Suavely or Dr Strabismus of Utrecht (whom God preserve). This book is undoubtedly required reading for anyone who wants to get on in his technological career—or indeed for anyone who has already got on and wants to keep it that way. **John Walker**

John Walker is an aspiring technocrat.

The handbook of artificial intelligence, vol I

edited by Avron Barr and Edward A. Feigenbaum

Pitman, pp 409, £15

The name and implications of the science of "artificial intelligence" will doubtless continue to offend oversensitive souls for some time to come. But workers in many fields now know that computer systems exist which can behave in ways which can be called "intelligent".

The world of artificial intelligence is the world of symbolic computation and heuristic programming, as distinct from numerical calculation and conventional data-processing. For the past 25 years the inhabitants of that world have tended to talk only to each other. Now, editors Barr and Feigenbaum of Stanford University declare, the time has come for artificial intelligence or AI to "go public".

Hence this three-volume *Handbook*, intended as a guide, an encyclopaedia, an explanation of what AI research is all about. For AI students and for the world outside, it covers the subject area by area, in a comprehensive assembly of broad surveys and detailed articles. This first volume deals with fundamental techniques such as how to represent knowledge, how to simplify problems and how to search for solutions; and with systems for understanding plain language, both written and spoken. Volume 2 will include programming languages and the knowledge-refining "expert systems" in science, medicine and education. Among the items promised for Volume 3 are models of cognition, automatic deduction, vision and robotics.

A basic chicken-and-egg problem emerges in the relationship of the "thought processes" of the AI computer systems to those of people. In effect, what much of the AI research is aiming to do is to reproduce or simulate the mechanisms of human intelligence. But those mechanisms are themselves not understood. How do we recognise a face, how reason by analogy? So, why not use our stumbling progress towards "intelligent" computer systems to teach us about our own intelligence? No reason at all why not, but don't expect too much. AI scientists have written programs that can, in certain tasks, perform as well as (and occasionally better than) human experts. Most of the methods adopted are patently *not* the same ones as those used by people—but some of them might be.

Whether or not the AI work leads to a better understanding of the mind, Barr and Feigenbaum argue, there is every evidence that it will lead to a new, intelligent technology that may have dramatic effects on society. The role of computers in our lives has evolved from remote to commonplace; and AI concepts will play a key part in the expected further evolution from useful to essential.

Ed Feigenbaum's Computer Science Department at Stanford is a recognised centre of excellence in artificial intelligence research. The handbook was put together there, clearly with great care and scholarship and with contributions from other centres in the United States including MIT; Carnegie-Mellon, Rutgers and Indiana Universities; and SRI International. The "overview" surveys at the start of each chapter sketch the relevant research history and summarise the state of the technology. Those on understanding natural language and spoken language are particularly good examples. Throughout the book, other key sources are closely woven into context.

"The excitement of creating a powerful new technology is coupled in AI, as perhaps in no other field these days, with the potential for stumbling upon new insights into one of the *big* questions", Barr and Feigenbaum sum up in their introduction. "Physicists ask what kind of place this Universe is and seek to characterise its behaviour systematically. Biologists ask what it means for a physical system to be *living*. We in AI wonder what kind of information-processing system can ask such questions."

Kenneth Owen

Kenneth Owen is a freelance technology writer with a special interest in artificial intelligence.

The Camera Obscura
John H Hammond
The fascinating illustrated history of the original 'camera', an optical viewing instrument once widely used by astronomers, artists and entertainers, but now almost forgotten except by historians and collectors, by whom the early instruments are greatly prized. This chronicle of its long history is told through the writings of those who made or used the camera obscura for scientific or artistic purposes, and those authors who recorded its varied uses. The book is extensively illustrated with archival material, diagrams and photographs of surviving instruments.
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Paul D Sherman
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Bart J. Bok & Priscilla F. Bok
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Stephen Michael Kosslyn

In *Image and Mind* Kosslyn makes an impressive case for the view that images are critically involved in the life of the mind. In a series of ingenious experiments, he provides hard evidence that people can construct elaborate mental images, search themfor specific information, and perform such other internal operations as mental rotation. Kosslyn offers a model of the mind and provides an integrated account of most of the modern empirical results from imagery research within the framework of a coherent theory. £14·00

Radiation Protection

A Guide for Scientists
and Physicians

Jacob Shapiro
Second Edition

The object of this book remains the same: to enable the reader to protect himself and others, and to understand and comply with all regulations regarding radiation use. The sections on dose calculations, medical radiation, natural radiation, calibration and the use of detectors, regulations, and control methods have been expanded and new material has been added to the sections dealing with nuclear power, nuclear weapons, and major radiation accidents. *August*, £17·50

HARVARD

REVIEW

Making information systems work

by Trevor J. Bentley

Macmillan, pp 229, £20

If the computer salesmen are to be believed, then all the go-ahead business needs do to keep the profit rolling in is to install a large central computer—or alternatively a constellation of interlinked mini-computers—hire a data base manager, buy a suite of applications programs and, hey presto, dream becomes reality. The truth is somewhat more complex than this.

While it is true that computers can and do improve good company systems and can be used in highly imaginative and effective ways, they can also bring added chaos and a dangerous inflexibility into a company—unless their introduction is accompained by a corresponding application of logic and common sense. There is, in other words, no automatic correlation between the installation of computer power and improved company performance. Indeed, the unthinking and muddled application of the computer in a company with ramshackle systems could hasten the downfall of that company.

Trevor Bentley attempts to demystify the world of company information systems and the role of the computer. Keep the systems simple, use computers where appropriate, but recognise that they cannot do everything and that occasionally a good manual system will be better than a computer system. Above all, use your common sense and do not become overawed, either by the jargon of the computer world, or by the proponents of the "totally integrated company information system". The latter does not exist, except perhaps in the imagination of those who would sell you "The office of the future" today.

This book makes some useful points, but is not particularly cohesive and shows slight signs of having been put together in a hurry. Nevertheless it should prove a useful antidote that can be administered to anyone suffering from the cultural shock that sometimes results from over-exposure to computer systems seminars.

Antony Anderson

Looking ahead

THIS AUTUMN'S lists reveal the mood of reflection which seems to be settling over the scientific community. Scientists as well as science watchers are re-examining the lessons of history and considering the effects of their work

One of the most all-embracing accounts is that of Vincent Cronin in **The view from planet Earth,** which Collins will publish at £9·95. Writing for the non-specialist, he documents man's changing view of the Universe, examines the relationships between technological progress, scientific discovery and philosophical interpretation, and looks at their influence on the arts. Augustine Brannigan focuses on what we mean by a scientific discovery and how society recognises it in **The social basis of scientific discoveries** (Cambridge UP, £14·50, ppb £4·95). His sociological approach offers a different perspective from that of historians of science.

Science in America edited by Nathan and Ida H. Reingold (Chicago UP, npg) is a collection of letters, memoranda and other documents of scientists in the US from 1900 until 1939. A new series from Frederick Muller brings history right up to the present. **The biographical encyclopaedias of science** cover classical figures who contributed to the state of knowledge today, but make a point of including contemporary figures such as Patrick Steptoe and Christiaan Barnard. The first two volumes, **The biologists** and **The chemists** will be available this autumn at £8·50 each.

The dictionary of the history of science edited by W. F. Bynum, E. J. Browne and R. Porter (Macmillan, £17·50) also covers contemporary issues in its short historical accounts of the important themes, concepts and discoveries of science. Dent aims to capture the popular science market by teaming up Magnus Pyke and Patrick Moore on **Everyman's scientific facts and feats** (£8·95), which is both a catalogue of facts and figures and an accessible history of science.

Computers have only become a part of everyday existence in the past decade or so, but their history goes back more than a century. One of their originators is commemorated in **Charles Babbage: pioneer of the modern computer** by Anthony Hyman (Oxford UP, £12·50), which documents his struggle to achieve recognition for his "engines". For today's prospective computer user, the science fiction writer Frank Herbert, together with Max Barnard, has produced **Without me you're nothing** (Gollancz, £6·95). In clear, non-technical language, they explain how to program a home computer and how to choose one to suit your needs. You might also want to equip yourself with **The Penguin dictionary of microprocessors** by Anthony Chandor (Penguin, £6·95) to unravel the mysteries of raster counts, hex pads and mother boards.

Those who thought there wasn't much to laugh at in civil engineering might find a lighter side in **Getting sued and other tales of the engineering life** (MIT, £9·30). The author, Richard Meehan, recounts bizarre or hilarious incidents from his life as a peripatetic consulting engineer. David Baker documents the first 20 years of man in space in **The history of manned space flight** (New Cavendish, npg), examining both the politics and the technology. **Red star in orbit** is James Oberg's account of the Soviet space programme, and his researches uncover unpublicised disasters as well as successes as the USSR vied with the US for supremacy in space. It will be published by Harrap at £7·95. The nuclear threat is the background to Norman Moss's **The politics of uranium** (Deutsch, £5·95), which offers facts and figures about the sources and properties of the element, while concerning itself mainly with political questions. ☐

Looking ahead

Readers are advised to check prices when ordering titles

The Organisation of the Cerebral Cortex
editors, Francis O. Scmitt, Frederic G. Worden, George Adelman, and Stephen G. Dennis
The 22 papers in this book (originally presented at a Neurosciences Research Program Colloquium) are grouped into 6 sections: Development, Plasticity, and Evolution of Neocortex; Functional Microorganisation in the Cerebral Cortex; Organisation and Connections of the Neocortex; Chemical Signalling and Circuitry in Cerebral Cortex and Its Interconnections; The Role of Cerebral Cortex in Higher Brain Function; and Impact of Theoretical Constructs and Modeling of Cortical Function.
0 262 19189 X, 608 pages, £31·00

Environmental Law in Japan
Julian Gresser, Koichiro Fujikura & Akio Morishima
After surveying the history of pollution controls in Japan in the 19th and 20th centuries, the authors examine Japan's innovative approaches in pollution trial decisions, regulatory processes, compensation for pollution-induced injury, and the settlement of environmental disputes.
0 262 07076 6, 1056 pages, *£42·00*

A Search for Structure
Selected Essays on Science, Art & History
Cyril Stanley Smith
In these 14 essays Smith, metallurgist and philosopher, considers that historically many advances in metals and ceramics came about through aesthetic curiosity and the desire to improve works of art, rather than through scientific investigation or the need for practical utility.
". . . a man equally at home with his hand on the microscope or above the etching bath, pondering a subtle vellum manuscript or a complicated phase diagram, a scientist, a reflective craftsmen, a scholar, a teacher and a connoisseur."—*Scientific American*
0 262 19191 1, 416 pages, 250 illustrations, £21·00

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H. Max Irvine
Cable Structures can be directly consulted by the practicing engineer confronted with a mooring-line problem, or called on to provide a dynamic analysis of a cable-suspended roof; although practical applications are stressed, the level of mathematical rigour is such that it can serve as a basic text and as a reference for researchers at the vanguard of the field.
0 262 09023 6, 304 pages, £28·00

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James R. Melcher
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Contents: Introduction to Continuum Electromechanics; Electrodynamic Laws, Approximations, and Relations; Electromagnetic Forces, Force Densities, and Stress Tensors; Electromechanical Kinematics; Energy-Conversion Models and Processes; Charge Migration, Convection, and Relaxation; Magnetic Diffusion and Induction Interactions; Laws, Approximations, and Relations of Fluid Mechanics Statics and Dynamics of Systems Having a Static Equilibrium; Electromechanical Flows; Electromechanics with Thermal and Molecular Diffusion; and Streaming Interactions.
0 262 13165 X, 484 pages, £26·25

The Origins of Cauchy's Rigorous Calculus *Judith V. Grabiner*
This book explores the rigorous reinterpretation of the calculus undertaken by Cauchy and his contemporaries in the early 19th century.
0 262 07079 0, 294 pages, £17·50

The Massachusetts Institute of Technology **THE MIT PRESS** *126 Buckingham Palace Road, London SW1*

Energy Economics
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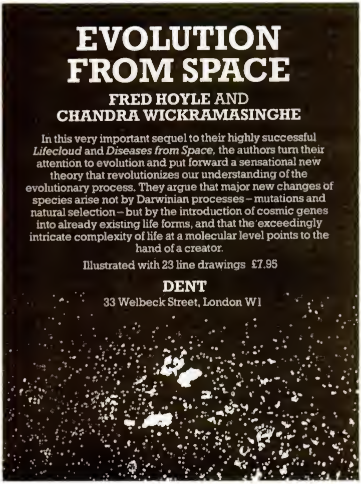

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REVIEW

Audience

Second wildlife film-makers symposium

Bath, 23-27 September

Nearly 200 independent and TV film-makers and producers from Britain, Europe and the US converged on Bath University for this five day symposium on the theme "Towards 2001" which celebrated 50 years of the British Kinematograph, Sound and Television Society (BKSTS).

The meeting was chaired by the indefatigable Jeffery Boswall, a TV producer in the BBC's Natural History Unit for 20 years. He had arranged an enormously varied programme of events covering films and discussions on many aspects of film and sound production for wild life filming.

Concern for conservation in the face of such statistics as "one fifth of all wildlife will be extinct, and all lowland habitats will have gone by 2001" was a major aspect of the symposium. The problem was to present through the medium of film the need to protect and to defend the environment, and to show our interdependence with nature.

The session opened with an impressive look at film-makers Alan and Joan Root in the award-winning Survival-Anglia film *Two in the Bush*. Filmed over a number of years, the Roots were shown tackling such problems as filming inside a hornbill's nest (that took two years, from locating a suitable site and setting it up, through the long wait for a nesting pair to move in, until the third chick finally chiselled its way out of the nest).

The Roots work as a team of two, having complete control over all aspects of their film: filming, sound, editing and so on. This is in direct contrast to Chris Parsons's (head of the BBC's Wildlife Unit) view of the future direction of wildlife films. He believes that the TV audience is becoming more demanding and needs a wider approach. So the trend is towards enormous projects that demand a great deal of research and planning: cameramen to work with field biologists and a huge production team to coordinate the elements involved. The whole production is planned, nothing left to chance, with very high budgets but great rewards when the project works. David Attenborough's *Life on Earth* was such a project and a new series on animal behaviour to be screened next year is another. This viewpoint was very unpopular with the small independent film-makers present at the symposium and caused some altercation.

The question of ethics recurred throughout the symposium, and a lively debate took place with the aim of creating a code of practice for film-makers. Jeffery Boswall's question raised 19 years ago and still relevant when applied to a natural history film was: "Has it been made by fair means or foul?" More specifically he asks, "Did the organisms suffer any cruelty or unreasonable disturbance?" and "Is watching the film a true-to-life experience within the accepted conventions of film making?"

James Murray, from Canada, executive producer of a CBC programme called *Nature of Things* tries through his programmes to reach out beyond the environmentalists in Canada where the environmental picture is bleak. His method is to show the incomparable beauty of an endangered area such as Cresswell Bay and Lancaster Sound in Canada's North West passage, areas that may be affected in the ever-increasing search for oil. He then cites specific areas which are most at risk. The statistics are horrific. Something like 60 per cent of Arctic birds nest in these areas, three-quarters of which could be wiped out by an oil spill.

The overwhelming impression gained from the symposium was of a dedicated group of film-makers hoping to prevent the loss of our habitats and wildlife through making the public aware of the problems and putting pressure on the powers that be to do something about it. Let us hope that they succeed.

Chris Jones

FORUM

Geology versus dogma

Roy Herbert finds a meeting point between East and West views on continental drift

NOTORIOUSLY, being a pig in the middle is a position of some risk. But that is where *New Scientist* finds itself in the matter of drift versus fix. On the one side Dr Robert Muir Wood of Trinity Hall, Cambridge, a consultant geologist, and on the other A. Monin and O. Sorokhtin, respectively an associate member of the Academy of Sciences of the USSR and a doctor of physical and mathematical sciences. Not that the pig has had to contend with a fast and furious game. The opening shot was fired by Wood in 1980. The return took nearly a year.

What started the contest was Wood's charge that Soviet geologists had been slow to appreciate the significance—if not the revelation—of the theory of continental drift or plate tectonics, according to which slow movements of the continents are caused by vast areas of the upper surface of the Earth being moved on what lies beneath. The plates, either widening gaps between them or the meeting and moving of one over the other, are responsible for massive geological consequences, such as the formation of oceans, deep ocean ridges, mountain ranges, belts of volcanic activity and so on. The charge, buttressed by a short history of Soviet geology since the time of the revolution (according to Wood), was laid out in an article in *New Scientist*, 12 June, 1980. A lot of it was concerned with the career of Vladimir Vladimirovich Beloussov, a distinguished geologist who, apparently, would have none of the drift theory; was adamant for "Fixism", which maintained that movements of the Earth's crust were up and down, expansions and contractions only; and was influential enough to shackle the minds of younger geologists with the aid of Marxist dogma. The proof of this, said Wood, in essence, was the dearth of Russian papers on drift, and absences of young Soviet geologists at international conferences; no wonder, considering the ordinary difficulty that a Russian researcher finds in obtaining journals and reports printed in the West.

All this to us, of course, is part of the every-day flow of opinion and argument, even if prejudices are deployed. There is nothing heinous or appallingly offensive about it. It is part of the rough and tumble of change in the scientific and academic worlds.

Not so to the Russians, whose reaction, taking so long, appears to confirm at least part of Wood's remarks. A. Monin and O. Sorokhtin have a go at Wood and at *New Scientist* for printing such a load of old noddy in (and this is where we smart) support of the "cold war"—harnessing geology to the propaganda chariot. "This publication is quite well known," they say of us, "and claims to be serious in its approach to scientific problems and to be scientifically objective." The magazine is taken severely to task by the two Russians in *Literaturnaya Gazeta*, 3 June, 1981. It is not every day that *NS* is accused of descending to unworthy pettiness and hostility to Russia and Soviet science. The two writers, however cogent their arguments, are clearly unable to distinguish between an article in a magazine and the magazine itself, which is probably not surprising. Neither is the vehemence, for even a mild criticism from outside is enough to provoke the Soviet establishment into going red in the face.

Mark Thomas

However, according to the two Russian contributors, the theory of continental drift has had far from a thin time in the USSR. It was accepted, admittedly not widely, as early as 1925, when American and British bodies were scornful of it. By the end of the 1960s, "fixists" in the country were on the skids and in the next decade had become a minority. Extreme fixists, they say, can now be counted on the fingers of one hand. They name many scientists who have done much for the spread of drift theory. Not only that, but Soviet scientists, they say, developed a model for the structure of oceanic plates that is universally accepted and have published a thousand scientific works on the theory, a lot of them in journals translated into English, so Wood ought to know all about this.

The Soviet authors add, quite reasonably, that Western scientists need the Russians' conclusions and vice versa, for common advantage, though they take a highly moral tone in sympathising a little with the editor of *NS* for finding himself associated with Wood as a "science snob" and captive of propagandist dogma.

This is fairly bruising stuff, however quickly the bruises fade, for a journal innocently publishing an article of some interest by an author of some repute in the field. While applying ointment, and wanting everyone to have a fair whack, *NS* received a rejoinder from Wood, only to find a few dangers of contusion from that direction, too.

For Wood, though pointing out the rhetoric in the Soviet reply, also says that he wrote the original article partly to provoke response from the USSR and that, in one sense, the Russians had "far greater pluralism of ideas" about the question, because in the West opposition to plate tectonics would bring social and professional obloquy. He conjectures that drift will now become the official Soviet line on geology and always will have been. Not that geologists in Britain were quick to seize on the theory of plate tectonics. "When continental drift hit England in 1921-22 it was not even discussed at meetings of the Geological Society". "So there!" might be a cry from the audience, but whether in English or Russian it would be hard to tell.

The Russians, we are assured consider that Anton Chekhov is a comical playwright. Perhaps we shall never understand each other's humour. Wood finished his article with a joke, suggesting that fixist theory would best suit the red planet Mars. The Soviet reply takes this seriously and, po-faced, explains that it is not possible to transfer geologists there. "Even the scientists of the various countries are faced with toiling on the one planet," they grind out. It's a nice use of "even". ☐

Nuclear examination

THE CAR INDUSTRY has long known that the most dangerous component of a vehicle is the nut that holds the wheel. The nuclear industry is still grappling with a similar problem. All the various official investigations of the accident at Three Mile Island (TMI) agreed that inadequate training and qualification of reactor operators played a key part in the accident in 1979. The industry at once laid down stringent additional requirements for its reactor operators. Last April, in preparation for the proposed restart of the undamaged TMI-1 reactor, its operators took a licensing examination set by the US Nuclear Regulatory Commission. On 17 August, however, Harold Denton, director of the NRC Office of Nuclear Reactor Regulation, wrote to Herman Dieckamp, president of General Public Utilities, owners of TMI, to tell him that all the TMI operators would have to resit the entire examination. At least two of the operators who took the examinations in April had been caught cheating. ☐

THREE MILE ISLAND
YOU DON'T HAVE TO BE TRAINED TO WORK HERE, BUT IT HELPS (A BIT)
L
Austin

W. Murray Todd

Pugwash flame flickers on

*W. Murray Todd attended the 31st scientific arms control conference in Banff, Canada, during 28 August-3 September**

"NEGOTIATION as an approach to arms control and disarmament, is the real alternative to the illusory hypothesis that security can be gained by an arms race, whereby one side obtains military superiority over the other," claimed George Ignatieff, Toronto University chancellor. In the face of the seemingly intractable problems posed by the threat of nuclear holocaust and the search for world peace, the Banff Pugwash conference produced some dramatice moments. A senior Egyptian scientist vigorously condemned the Israeli attack on the Iraqi Osirak reactor being constructed by French technicians. This outburst prompted other scientists at Banff to mount an impassioned defence of the Israeli action. Russian Academician Arbatov, of the Institute for US and Canadian Studies, declared that "The only obstacle to arms control is the position of the United States". The failure of the nuclear powers to control their own level of weapons, and the view that neither Eastern nor Western scientists comprehend the interlocked nature of today's world. left African and Latin American participants worried that Pugwash might lose appeal to their colleagues.

The first "Pugwash" conference was held in 1957, at the height of the cold war, and derived its name from the fishing village and boyhood home of American industrialist Cyrus Eaton—he bankrolled the first few meetings. The Pugwash movement was inspired by the manifesto penned in 1955 by British philosopher Bertrand Russell and endorsed by Albert Einstein. The Russell-Einstein manifesto called on men of science to assemble in conference to appraise the threats posed by the development of weapons of mass destruction . . . "not as members of this or that nation, continent or creed, but as human beings, members of the species Man, whose continued existence is in doubt. The world is full of conflicts . . . we shall try to say no single word which would appeal to one group rather than another. All are equally in peril, and if the peril is understood, there is hope that they may collectively avert it."

Such hopes were the legacy of thinkers of the 17th century enlightment, including John Locke who judged that social problems had solutions that could be arrived at by rational deliberation between men of goodwill rather than by political conflict. Martin Kaplan, director general of Pugwash, commented that there have been seven symposia and workshops in the past year—a record and by inference a rebuke to those who have declared Pugwash an anachronism. At the same time Kaplan worried aloud about the movement's reputation for being elitist and secretive (meetings are held in camera and the press is not invited); about its confusion over the developing world; and about the shortage of funds and young scientist recruits. He noted also the thinning ranks of senior Pugwash spokesmen—eminent scientists who in the past often had the ear of government leaders.

The conference called for a nuclear freeze by the two superpowers. It also expressed deep concern over the destabilising systems now being developed, including cruise missiles, strategic anti-submarine warfare, anti-satellite weapons, and Eurostrategic systems with "counterforce capability including Soviet SS20, Pershing II and cruise missiles". The proposal was that control of these systems be given priority in forthcoming negotiations. Of the 82 papers presented at Banff roughly 25 were on arms limitation, 13 on the psychological environment of the arms race, nine on energy, nine were general exhortations for peace and the rest were scattered about a wide topical landscape.

Scientists of the North are beginning to understand what those from the South have known all along, namely that in public policy there are no technological fixes, only political ones. Nevertheless, as the oldest arms control discussion going, Pugwash has not been without effect on the intellectual climate surrounding the discussion of the nuclear arms race. Last year's conference had scientists from both East and West agreeing that four nuclear fallacies persisted in the political arena. The first is that nuclear war can be limited in quantity or quality, or that it can even be won. The second is that civil defence can provide a chance of survival for the community. The third is that a first strike counterforce strategy can destroy the retaliatory capacity of the other side. The final fallacy is that parity in nuclear weapons is necessary for effective deterrence.

Pugwash at the age of 24 is troubled by the profound difficulty of the issues it addresses, by its own conventions, by the amateur nature of the effort put forth, and by a sense of opportunities missed. Lord Noel-Baker (93), however, delivered, without notes, a 45-minute soul-stirring address at the close of the conference. His prescription? "Answer the bureaucrats—that's Pugwash task number one!" A challenge indeed for the participants at next year's conference in Poland. ☐

W. Murray Todd is a Washington consultant and writer on science and public issues.
***Extra material by Mark Dixon**

Vacant plots in space town

Peter Marsh has recently visited Houston

HOUSTON in the 1960s was called "space city". Nowadays, the name is all wrong: it ought to be "money city".

The former title derives from NASA's Johnson Space Center, sited some 30 km from downtown Houston. Established in 1962, the base controlled the exciting burst of space missions that paved the way for the first Moon landing in July 1969. At one point during this frenetic period, the US was putting two people into space every six weeks or so.

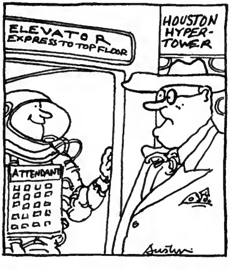
The pace has slowed right down, however. Since the last Apollo mission in

July 1975, the US has managed to get people into zero gravity just once—during the two-day maiden mission of the space shuttle in April. By the standards set by the Soviet Union, the record looks dismal. Since being beaten in the race to the Moon, the Russians have concentrated on keeping people in orbit for long periods aboard space stations. Over the past six years, Soviet cosmonauts have spent 54 man-months closetted inside metal cylinders whizzing about outside the Earth's atmosphere.

Further launches of the shuttle, the next of which should occur later this month, should improve matters from NASA's viewpoint. If all goes well, by the late 1980s the shuttles should be travelling into space at the rate of one a week. Much of the planning—and the control of the flights during orbit—will be done from the Houston Space Center. Little of this seems to bother the citizens of that city, however. They refuse to be deflected from their main preoccupation in life—making money.

The number of people in Houston has quadrupled since 1940 to 1·7 million—which makes it the US's fifth most populous city. The place is still growing. Some 100 000 people come to live in the city and its surrounding district every year; one new person moves in every five minutes. Mainly, men and women come to Houston (often from the economically depressed areas of the northern United States) because business is booming and there are plenty of jobs.

A glance at the yellow pages in the telephone directory tells much about Houston. There are 13 pages devoted just to oil companies; indeed, 430 such firms have offices in the city. Building contractors claim another 13 pages; firms connected with building services have seven. There are four pages of companies that provide concrete, and crane-hire outfits fill up another two.



To say that, in Houston, buildings are mushrooming is to vest in this humble plant growth-qualities of unbelievable proportions. The centre of the city looks as if it is the work of a demoniac giant who has run amok with an unlimited supply of concrete, glass and steel. In the 1970s, contractors provided some 4·5 million sq.m of leaseable office space. And in 1979 alone, the city authorities handed out 34 000 permits for new construction projects. There are no zoning laws, so people can build more or less where they want—which speeds up the whole building process considerably.

Along with the new buildings have come roads. There are some 320 km of freeways in Houston—something like a quarter of the total length of motorways in Britain. The city builds roads so fast that, according to one taxi driver, they often forget to finish them. Indeed, on one journey my taxi was forced to swerve off the road just in time to avoid a dead end. The mishap didn't matter very much as, by the convenient expedient of driving over a grass verge, we managed to reach another road where the journey could continue.

With the preoccupation with motorways comes an almost fanatical worship of the internal combustion engine. One day I was in Houston, the front-page story in the local newspaper described how the roof of a garage had fallen in, "injuring" several cars. In traffic jams, according to local folklore, people have been known to get so exasperated that they get out and shoot each other. Not that people are wedded to their cars altogether. The city is so big—it stretches 80 km from side to side—that people commonly take an aeroplane from one part to another.

Let's hope the shuttle is a success: it might slow Houston down. ☐

ENIGMA

No. 129

Do you really know your tables?

by Ian Haggarty

USING the conventional notation that each letter stands for a different digit the word TABLES can be "topped" by multiplying by three, ie

TABLES x 3 = ABLEST

and "tailed" by multiplying by five, ie

TABLES x 5 = STABLE

What is the numerical result of multiplying TABLES by seven?

A £5 book token will be awarded to the sender of the first correct solution opened on Thursday, 15 October. Please send entries to Enigma No. 129, New Scientist, *Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No. 126, Mostly right, was B. Morrison of Tyne and Wear.*

Answer to Enigma 126

Mostly right

373065

Conservationists and all that

Peter Marren tackles some vogue words

PUBLICLY I UNINTENTIONALLY used that accursed word "conservationist". Cursed because, like many recent "in-words" which have crept too quickly out of dusty dictionaries into popular parlance, its meaning has become rather muddled. That is to say, it means different things to different people. Practically everybody now claims to be a conservationist at heart—a sure sign that the word has been linguistically tampered with. It has become a sort of emotional trigger: conservationist = sensitivity, intelligence, sunshine and buttercups, nice person. In that sense, there is an implication that if you are not a conservationist, you are a bit of a rotter. Thus the word has been diluted until all the original meaning has washed away.

To get at the real meaning of the word before the media mob got to work on it, one must consult the dictionary. *Conservationist:* noun, derived from verb trans. to conserve. *To conserve:* to preserve fruit in syrup or sugar, usually jam. So, presumably, if you make homemade jam, you are a conservationist. My local farmers not only make jam, but also set aside "conservation meadows" which produce hay feed for their cattle in the winter months. That makes them conservationists twice over. It now becomes clear what nature conservationists are up to: they are busy making wildlife jam, or, alternatively, trussing up wildlife into bales and feeding them to cows.

The media make a distinction between conservationists and environmentalists. The former are nearly always old ladies, retired colonels, bug hunters, Morris dancers and people who live in thatched cottages and keep bees. Now the environmentalist is quite different. He may be a teetotaller, a vegetarian, a long-haired layabout, a nut-case or a middle-ranking civil servant—sometimes all of them at once. Whichever he may be (there are very few female environmentalists), he is usually a great deal noisier than a conservationist, lives in an urban tenement and never keeps bees. Actually there are more environmentalists around than the media realise. The word means "someone who is environmentally aware," that is to say, aware of their surroundings; indeed anyone who is aware that they exist at all becomes, *ipso facto*, an environmentalist.

Finally there is a third ist-person who is sometimes confused with the previous two: the biologist. Now *we* all know what a biologist is, but to those outside our arcane profession, it is a word redolent of deep mystery. That harassed housewife in one of the soap powder ads gave the popular view:

Peter Marren is a writer and broadcaster on countryside matters.

Unemployed Actor: Hey, you there Madam, yes you, don't buy that old stuff, try our new active Zap!
Harassed Housewife: Oooh, I dunno, is it biological?
Unemployed Actor (in simulated triumph): Yes, new Zap *is* biological!
(sings) It washes your things
While you dances and sings.

So ordinary people think that biological means something that sells soap, and they might reasonably infer from this that a biologist is the chap who helps to put the zing into Zap.

Let us recapitulate. A nature conservationist is a person who makes buttercup jam or who sugars chaffinches. An environmentalist is a person who knows he exists and says so, usually noisily. An environmental conservationist is someone who is aware that he is making jam. And a biologist is probably the little man pictured on the back of a packet of soap flakes who announces a free napkin ring in exchange for 35 packet tops. Hooray, at last these words have a precise meaning. Perhaps we should now pack up words like conservationist and store them back in the dictionary. ☐

TV science programmes

REMEMBER all those times you grumbled into your beard about the dreadful science programmes on TV, and how you could make them far better? Now is the time to stand up and be counted, for the inner cabinet of Channel 4 wants all the ideas it can get. What is more, science commissioning editor, Liz Forgan, promises to act as a "marriage broker" between prospective programme makers and production teams.

In theory the field is wide open: Paul Bonner, deputy (commissioning) to Jeremy Isaacs, wants to look for new approaches that will be complementary to coverage on the other channels, rather than in direct competition. Liz Forgan says that she is even willing to consider that a scientist talking to the audience and writing on a blackboard might make good television. This type of option earned the nickname "naked intellectualism", since elided, it seems, into the "naked intellectual" spot.

The reality, though, is that the work from independent television companies, who already have all the programme-making resources and expertise, is likely to dominate the scene—at least initially. Several companies have already made heavy investments in science series for Channel 4—and have drawn in a number of scientists and science journalists along the way, at their own initiative. (The Channel 4 supremos have not yet made a firm commitment to buy any of these.)

So TV4 intends to treat science and technology as seriously in its news broadcasts as Westminster politics. If this means that science and technology are to be treated largely as "current affairs" rather than mere geewizery and egg-headery then this can only be for the good. ☐

A SMALL ENTRY for my most recent comp (blurbs for books that never had one) but of gratifyingly high quality. So much so that I have been unable to decide between Martin Lewis's Copernicus and C. Hill's Bacon; a £5 book token to them each. And a special mention for the last line of Ian Moules's blurb for Newton's *Opticks:* "A book suitable for a wide spectrum of people."

De Orbium Coelestium Revolutionibus
Perhaps the most arrogant title of the year, and yet at the same time the most modest; for implied herein is nothing less than a complete revolution in our view of the Creator's handiwork. With what care we have maintained our central position in His scheme of things; yet now we are told that the great design is vaster even than we knew and considered sufficient, and still more incredibly, that the very Earth itself is in rotation. Contrary it may be to any vestige of commonsense, yet the author (himself in clerical orders) argues thoroughly that his idea must be so, and must sow at least a doubt in the most confident mind of every basis of thought. A revolution in truth; the planets, for all their greatness, the least of it.

Advancement of Learning
Mr Bacon, before we made him Knight and generall Busybodie, bemoaned Our lack of a Boke about Bokes, or Repositorie of wisdom. Since We did him this favour, he hath complained oftener that his new Courtly Station entitleth him to no Shred of further knowledge. This is because (and who should know as well as We, who have written copious Volumes on the issue) of Witches and daemonic Beasties, which stifle men's minds and turn them to baseness, chimistrie, and divers other experimental Follies; and there shall be no fresh Theories or Enlightenings except they avoid such Bokes and Witches and pettie Authors, which are a Curse. But as a Patron and King, to whom Mr Bacon hath dedicated his unwholesome Lists and false Appraisals of Man's poor bodie of Conjectures (by some called Science), We offer Our high Opinion of his style and Popular Manner (which justifieth his Sales, exceeding 10 per annum), though modestly reserving Our Judgement on his headstrong Speculations, strange Coinings of words, and political Prospects.

James

NB The Author advises Us that there is as yet no Printing in soft covers. This is a Fault, or Deficiency.

* * *

FOR THIS MONTH'S COMP, I intend to revive interest in all the spacecraft presently dodging planets on their way out of the Solar System. You will recall that these contain pictures and gramophone records, items that we consider sufficient proof of our intelligence. But if there is life Out There, will it recognise the spacecraft and their trinkets? And if They did pay us a visit, how would you persuade them that you were intelligent?

Keep your answers brief, please, and get them here by 26 October at the latest. The usual £5 book token to winners. ☐

France aims for Japanese-style industrial boom

Daniel S. Greenberg looks covetously at President Mitterrand's support for technology

NEWLY INSTALLED political chiefs commonly summon a technological boom from their nation's laboratories, but not often does it come. With those odds understood, it should be noted that, while other countries are scrimping on research, the new French government has embraced it with Franco-socialist gusto and is planning big expenditures to inspire high-tech industrial growth. Success would inevitably add to the manoeuvrability and feistiness of French foreign policy, which has long recognised the link between political independence and technological prowess. Success is not improbable, for the French are adept at big projects.

With France already strong and self-sufficient in nuclear matters, both military and industrial, the government of François Mitterrand has moved quickly to begin filling critical gaps in the hot fields of biotechnology, microelectronics, and industrial robots. Scattered research facilities are being brought under the umbrella of a newly created Ministry of Research and Technology. The head of the ministry, Jean Pierre Chevenement, sees his fledgling organisation as a first step toward emulating Japan's fabulously successful Ministry of International Trade and Industry, the nimble orchestrator of Japan Inc's success in sophisticated export products.

AP

The French financial blueprint for invigorating science and technology calls for a "real" increase in research spending of 11 per cent a year for the next four years, with the goal of surpassing the United States in percentage of gross

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national product devoted to research and development. Over the past decade, the American figure has been sliding, and is now at about 2·4 per cent, while the French amount, though rising, is a touch under 2 per cent.

Given that French population and wealth are roughly one-fourth those of the United States, even that rapid annual growth still leaves France trailing in financial outlays on R&D. But the numbers fail to reflect that in shrewd and persistent fashion throughout the postwar period, France has enticed and cajoled its neighbours into sharing the costs of expensive advanced technology and scientific ventures beyond its own means.

Thus, when France latched onto the Concorde project as not merely an airplane-building project but also as a potent tonic for high-technology industry, it lured the British into cost-sharing with a promise of Common Market membership. Europe's ticket into space, the Ariane launch vehicle, is predominantly French in its industrial base, with heavy cost-sharing by Germany, Britain, and other nations. And, when it comes to the costliest of fundamental sciences, atom-smashing high-energy physics, France is the most steadfast supporter of multination investment in Europe's billion-dollar, world-league laboratory near Geneva.

Hooked on high-visibility symbols of technological grandeur, including an independent nuclear capacity, France has lagged in the brick-by-brick building of a national scientific enterprise that can nourish new industries. The neglect was regularly deplored by technocrats in the last government, and, off and on, raised promises of corrective steps. But the delivery failed to match the promises.

What is noteworthy about Mitterrand's fast start in quest of a technological boom is that it came quickly in his administration and without external urgings or the prod of a crisis. It looks as if the French intend to give it a hard try. ☐

Schools project work

Tam Dalyell MP attended a conference on gifted children

SOME PEOPLE even when nearing their eighties, retain a vigorous concern for the future—as if they were half a century or more younger. It is a marvellous attribute. Sir Nevill Mott, Nobel prizewinner, and former head of the Cavendish Laboratory in Cambridge is such a person. In conjunction with the Leonardo Trust, and Shell, he organised a week-end seminar on the problems of "Gifted Children and their Contemporaries" at Caius College, Cambridge, where he is a former master. The proceedings of the conference are to be published, and I am sure they will shed valuable light on how schools can help the child of high attainment to fulfil himself or herself.

I was particularly interested in the contributions of John Heaney and Francine Barlow. They eloquently represented the views of the Association for Science Education, and put forward some challenging views in their personal capacity. The Association for Science Education has formulated a list of aims, for science education in schools. One is "the utilisation of scientific knowledge and processes in the pursuit of further knowledge and deeper understanding, and the development of an ability to function autonomously in an area of science studies, to solve practical problems and to communicate that experience to others".

John Heaney enlarged on this aim. He believes that project work is the most effective vehicle for teaching "hard" science. Project work develops practical skills, planning, initiative, interpretation of results, and encourages the organised use of appropriate literature. Too often, said Heaney, pupils are expected to switch from a didactic and prescriptive approach to project work as an introduction to some of the important processes of science. The results can be disappointing. Heaney's experience is that able students in particular, faced by the demands of external examinations, are rarely given enough time for project work. Pupils need to be prepared for this type of work over a long period of time.

I strongly agree with Heaney's views, and believe that the development of project work in school is the most satisfactory answer for providing facilities to match the needs (and rights) of the pupil, capable of high attainment. (Only in mathematics/physics is there perhaps an argument for concentrating teaching outside the normal school framework.) But, it is precisely this project work that is being severely hit by the education cuts. It is difficult to do project work without laboratory technicians. Yet, many authorities have been forced drastically to cut ancillary help. Either sacking or failing to replace laboratory technicians in schools is a penny-wise, pound-foolish policy. If Britain is to live by its brains, this sinful cut in laboratory technicians, allied to the shortage in schools of text-books, and often simple materials such as paper, will prove costly in the long term. ☐

not nature

Burning editorials

Michael Kenward

THEY ARE AT IT AGAIN in Little Essex Street. Last week's *Nature* has an editorial entitled "A book for burning?" While most "popular science magazines", (like ours) to use a phrase culled from the editorial, prefer to review books with the reviewer's name appended, *Nature* slams anonymously into Dr Rupert Sheldrake's book *A New Science of Life*.

We wouldn't want to quote too much from the editorial—there are those of a litigious nature on that *unpopular* (by inference, their classification) science magazine who might do us for copyright—but its climax is fun: "Sheldrake's argument takes off from his catalogue of ways in which the molecular biologists, no doubt the shock-troops of the reductionists, have so far been unable to calculate the phonotype [surely some mistake here?] of a single organism from a knowledge of its genotype. But so what? Have not the past 20 years shown clearly enough that molecular explanations of biological phenomena are, contrary to some earlier expectations, possible and powerful? And who says that molecular biology must be counted as a failure for as long as embryology is not a branch of mathematics? Dr Sheldrake, whose background should have enabled him to know better, has done a great disservice by helping to give currency to these misconceptions and false expectations."

Magnanimously the anonymous writer concludes: "His book should not be burned (nor even confined to closed shelves in libraries) but, rather, put firmly in its place among the literature of intellectual aberrations." The editorial had earlier described the book as "the best candidate for burning there has been for many years". Sheldrake, whose ideas we have given space if not credibility, rang us to point out the masterly job that *Nature* had done on this book. No. The good doctor was not upset. He described it as "a tremendous boost for sales, an absolute gift". The book is now being reprinted and he wants the publisher to put the "candidate for burning" bit on the dust jacket.

Readers—of both *Nature* and *New Scientist*—with memories will recall a similar episode when *Nature* launched an attack on a scientist with somewhat unorthodox ideas not long ago. Then the battered scientist was Ted Steele. Does this mean that *Nature* has abandoned the scientific method whereby ideas are launched on to the world to be tested by the scientific community? Or are we to have trial by editorial? ☐

LETTERS

Bio-rights

When Lawrence McGinty, in his review (27 August, p 547) of Clifford Grobstein's *From Chance to Purpose*, asks Grobstein to help fight the possible abuse of genetic engineering is it not rather like letting the police deal with corruption in the force—ie indefensible? Perhaps he could explain why? When I want to move a door three feet in my own home I have to have planning permission and building regulation approval (28 forms and plans). Why then shouldn't all the gene-fiddlers need at the very least "mutant body building approval"? Is there a clear legal definition of what is ours alone and what is in corporate ownership? Are sperm and ova still classed as personal possessions or have I missed something?

I realise that this plea is about as useful as declaring my vegetable patch a "nuclear free zone". Despite my not being informed or consulted before, I would like to protest. I believe, even if it is the *only* right we have left, that the destiny of my DNA is a decision for *moi* alone. I presume that our geneticists have been fortunate enough to have a gander at the Cosmic Blueprints and this knowledge gives them the divine right to standardise everything. Surely it is the diversity of life that will bear the natural fruits of evolution, somewhere among the million N^2 individuals about. These are the people who should decide in such matters concerning the erosion of our rights and not a few hundred bio-barons in white coats.

Jean Cave *Bridgwater*

Entertaining soccer

I agree with Jack Dowie ("Football's failing—the deadly draw", 27 August, p 515) that there is strong evidence to indicate that the Football League's brave attempt to stimulate more entertaining soccer by awarding three points for a win is doomed to failure. However, it is a misinterpretation of the data to suggest that the draw is the cause of negative unattractive soccer and should therefore be abolished. It is a matter of simple statistics that the incidence of draws will rise as the number of goals scored decreases. Furthermore, Dowie's solution for abolishing draws by using goalkeeping "handles" as a match-deciding criterion is unworkable since it would impose a further burden of contentious decisions on the already hard pressed referees.

Draws, especially scoring draws, are not necessarily unattractive. It is the dearth of goals that is slowly killing the game. The solution, therefore, should be a direct reward for every goal scored above and beyond the reward for the result of the game. I suggest the old system (win: 2 points, draw: 1 point, defeat: 0 point) should be reinstated, and that every goal scored should gain an additional $\frac{1}{2}$ point for the scoring side, ie a 4-3 final score would produce 4 points for the winners and $1\frac{1}{2}$ for the clearly entertaining losers who under the present (unjust ?) system would receive nothing but applause. A further productive measure, I believe, would be the withholding of any points unless a team scores, ie the crowd-thinning no-score draw would become truly pointless!

Reassessment of end of season professional league tables using the above points system reveals that they are not changed beyond all recognition and/or meaning. However, high scoring sides do clearly migrate to the top, always avoiding relegation, while the unattractive, low scoring, machine-like spoilers usually found lurking mid-table drop deservedly into the relegation zone.

The system would lessen the current paranoid fear of losing since defeats will not necessarily be pointless and extra points can be picked up at a later stage by simply scoring more goals! One hopes that it would encourage managers to select more skilful, attacking formations, at the expense of the less productive, more physical "stoppers", which should, in turn, reduce the incidence of worrying (and crowd-violence inciting?) "dirty" play and "professional" fouls. Furthermore, every game should retain spectator interest right to the final whistle since the incentive to score extra goals is omnipresent whether or not the result is no longer in doubt.

Bob Day *Cape Town*

Radwaste and Windscale

A letter by D. Savage and N. Chapman (*New Scientist*, vol 90, p 452) contains serious errors of fact that call for correction and raises broader issues which merit consideration. Their letter deals with the immobilisation of high-level radio-active wastes (HLW) in SYNROC, a titanate ceramic wasteform under development by the Australian National University and the Australian Atomic Energy Commission.

Savage and Chapman appear unaware of the basic motivation for developing an advanced wasteform possessing greatly superior resistance to leaching by groundwater than does borosilicate glass. They argue that in an ideal geological respository, the flow rates of water past waste are only likely to be of the order of 1 to 2 litres a year through a square metre cross-sectional area, and advocate leach tests which model these ideal conditions. The results are excessively flattering to the wasteform, and make minimal demands on its capacity to immobilise radioactive wastes.

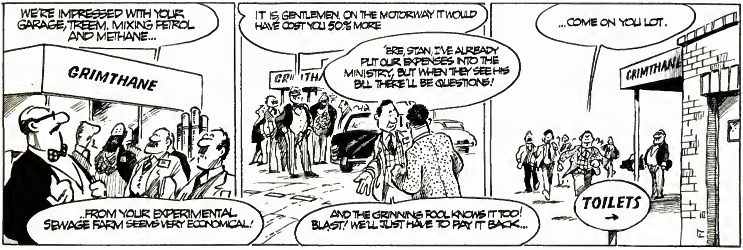
In real life we must always consider the possibility, however remote, that large volumes of groundwater may breach the repository, owing to unsuspected hydrogeologic factors; for example, fractures caused by tectonic activity, thermal stresses or human intrusion. In this event, the waste-form itself should function as an independent *immobilisation barrier* fully capable of preventing any significant access of radionuclides to the biosphere. Realistic leach testing should be designed to evaluate the performance of wasteforms under these conditions. This is the basis of our comparative testing of SYNROC and borosilicate glasses.

The authors attempt to denigrate these leach tests which show SYNROC to be vastly superior to borosilicate glasses. They state that our testing was performed under conditions "where the wasteform contacts infinite amounts of refluxing water, which is like suggesting that the wasteform should withstand disposal in a boiling waterfall". This statement is false. Our testing was closely based on the IAEA method, according to which the wasteform is contacted by small, fixed volumes of water for finite times (order of days), analysed for dissolved species, and then replaced by fresh batches of water. The IAEA method is widely used as a standard method for evaluating wasteform leachability.

Savage and Chapman also state "Different waste compositions can be accommodated simply by changing the glass composition. SYNROC has not proved to be as flexible, each waste composition requiring a separate mineral assemblage. The scale-up problems of this can be imagined." This statement is also false. The waste compositions accepted by SYNROC can be freely varied within the ranges of fission products and actinides produced by differing fuel cycles without altering its formulation. Likewise SYNROC can incorporate 5, 10, or 20 per cent of HLW without changing its formulation or substantially changing its leach characteristics.

Grimbledon Down

Bill Tidy


WE'RE IMPRESSED WITH YOUR GARAGE, TREEM. MIXING PETROL AND METHANE...
GRIMTHANE
..FROM YOUR EXPERIMENTAL SEWAGE FARM SEEMS VERY ECONOMICAL!
IT IS, GENTLEMEN. ON THE MOTORWAY IT WOULD HAVE COST YOU 50% MORE
'ERE, STAN, I'VE ALREADY PUT OUR EXPENSES INTO THE MINISTRY, BUT WHEN THEY SEE HIS BILL THERE'LL BE QUESTIONS!
GR THA
AND THE GRINNING FOOL KNOWS IT TOO! BLAST! WE'LL JUST HAVE TO PAY IT BACK...
...COME ON YOU LOT.
GRIMTHANE
TOILETS

LETTERS

They further state that SYNROC has not proven its capacity to incorporate the majority of fission products and actinide elements occurring in HLW. Wrong again! About 30 of the most important waste elements have been incorporated in SYNROC and there is no reason why the remaining minor elements should not be similarly introduced. With the possible exceptions of wastes containing large amounts of sodium and fluorine (for which additional tailoring is required), all elements which can be incorporated in glass can also be incorporated in SYNROC.

It would hardly be worth making an issue of these allegations were it not for the fact that other scientists associated with British nuclear waste immobilisation programmes have made similar unsubstantiated statements about SYNROC which are equally indefensible. Papers by Groves (*Radioactive Waste Management*, vol 1, p 1) and Tempest (*Nuclear Technology*, vol 52, p 415) fall in this latter category. One wonders why these scientists should be so anxious to denigrate a wasteform about which they obviously know so little.

The thermal conductivity and strength of SYNROC are about three times higher than glass. Although the production technology for SYNROC is at a much earlier stage of development than for glass, there are now sound engineering reasons to support the belief that disposal of high-level waste in SYNROC is likely to be both cheaper and radiologically safer to plant operators than glass production.

The Windscale reprocessing plant is estimated to cost about £1000 million pounds. The taxpayer is entitled to expect that the technology to be used has been evaluated rigorously and compared objectively with other technologies, *including those currently under development*. I doubt whether this latter obligation has been adequately fulfilled.

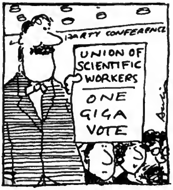
The Windscale plant will possess two French AVM melters operating in parallel to convert the wastes into borosilicate glass. The decision to employ this strategy may well be justified in current circumstances, since other technologies are not yet sufficiently advanced to be utilised. However, I venture to predict that by the time Windscale commences operation, its waste solidification plant will have become technologically obsolete, and glass may not be the wasteform preferred by society.

It might well be prudent for the management of Windscale to keep its options open and to design the plant so that its operation is sufficiently flexible to be compatible with technologies which are currently being developed with the objective of producing vastly improved wasteforms.

A. E. Ringwood FRS
The Australian National University Canberra ACT

Exasperated

I noted with interest your idea (Forum, 30 July, p 302) that we should go the whole hog in using SI prefixes. Some of us in energy research have been saying the same for megaseconds, but we have encountered a snag. You state that GNPs now reach well over seven figures and so are in the confusing realm of the billion. It is much later than you think. National energy usage long ago passed the realms of "giga" and "tera". Even the poorest countries can boast animal energy consumptions in the petajoule (10^{15}J) range.



Industrialised nations have soared into the exajoules (10^{18}J). In fact, total animal world energy consumption is presently 300 exajoules give or take a therm or two. It does not take too much foresight to see that as poor countries become industrialised we shall pass the point where the next SI prefix is needed. Hence the snag, for at least—according to my *Physics Handbook*—the next prefix does not exist. Tempting though it is simply to invent one ("hypa", "whoppa"?), I feel duty bound to inquire whether anyone knows if the official series extends beyond "exa".

I doubt that any other profession which has to communicate results throughout the world can have been saddled with such an inappropriately sized basic unit as to make following your admirable suggestion impossible.

Chris Hope Cambridge

Big bad bang!

I was pleased to read the letter by J. J. Sparkes (20 August, p 491), which made a rather neat point about the supposed big bang.

I have long been disgruntled by the categorical manner in which physicists deal out their current theories to the lay public. We all should know that, when physicists talk to each other, they use a sort of scientific short-hand: "The Universe started with a big bang" really means "A lot of evidence we have from observations plus a bit of paperwork fits (to my mind) best with the proposal that there was a big bang once". This is alright (sorry, Ariadne, that's how we learned it in school) but the general public doesn't know about the shorthand. Thus we listened to someone telling our 7-year-old it all started with a bang, and thus some non-scientific friends of mine asked me to explain to them all about those black holes out there—the impression is evidently given that we have *found* black holes. There are many other examples of this. If scientists (physicists are, of course, not the only ones guilty of this) were a little more careful in their expression, the public might in the end trust them more.

A propos the "big bang"—does not time itself get compressed in those first moments and if, logically, we go along with that compressed scale, should we not rename it the "big ffft"?

D. Britz Aarhus, Denmark

Pearl mountains

I have read Monitor's "Pearly price for wives and genes" (6 August, p 344) and until G. T. Nurse produces the answer, I shall not be able to relax in the restful way I am sure you would wish your readers to relax.

My question is simple, like the chicken and egg one. What happens to the tribe which lives at the top of the mountain and, presumably, must by now have accumulated a pearl-shell mountain of EEC proportions? Are they all congenital idiots, or of monkish inclination, or do they (unknown to G. T. Nurse) sneak down the other side of the mountain when he is not looking and recycle the pearly shell in the sea in an exquisitely ecological way—taking back any spare lurking in the bushes *en route*?

T. C. Kennedy London

Impalt?

The definition of "impalt"—to which a vacuum brush must not be subjected (Forum, 17 September, p 752)—is simple. Based on the legendary wickedness of imps, it is the SI unit for the height of wickedness, as implied by the tone of the rest of the article "You have been warned!"

Brian Nash Oxford

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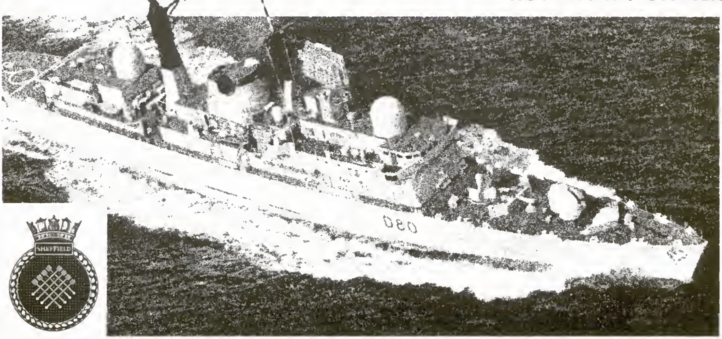

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Please write in confidence (quoting ref. BKT) to:—
The Director, The Malaysian Rubber Producers' Research Association, Tun Abdul Rezak Laboratory, Brickendonbury, Nr. Hertford, Herts SG13 8NL

HAMMERSMITH HOSPITAL
Department of Medicine
MEDICAL LABORATORY SCIENTIFIC OFFICER—£5817-£7852 PA INC

For Hormone Assay Laboratories in the Endocrine Unit. The laboratories provide service radioimmunoassays for Hammersmith Hospital, the Regional Health Authority, the Supra-Regional hormone assay service and are engaged in research in most aspects of endocrinology, particularly pituitary disorders. State Registration and previous experience in this field an advantage.

Application form and details from: District Personnel Department, Hammersmith Hospital, Du Cane Road, London W12, or telephone 743 2030, ext 49.

Closing date: 15 October, 1981.

LABORATORY SUPERVISOR

The Pall Europe Group of Companies are recognised as the leading manufacturers of fine and ultrafine filters. Expansion within their Scientific & Laboratory Services Group has created a vacancy for an experienced LABORATORY SUPERVISOR.

The successful applicant will be responsible for the organisation of a Contamination Laboratory. They should be familiar with optical and Electron microscopes, automatic particle counters and all allied techniques for the examination of fluid samples and filters involved in a variety of industrial, medical, aerospace and research applications.

Candidates should be over 25 years of age with a good academic background and have at least 5 years Laboratory experience, preferably in a manufacturing environment. Previous Supervisory experience in this field would be an asset.

The salary is negotiable commensurate with qualifications and experience. Other benefits include an excellent superannuation scheme and 24 days holiday plus statutory holidays.

For an application form please telephone or write to:

Mr R. G. Norton, Personnel & Training Manager, Walton Road, Farlington, Portsmouth, Hants. PO6 1TD

Telephone: Cosham (0705) 370901

PALL

UNIVERSITY OF BIRMINGHAM
Department of Electronic and Electrical Engineering
Wolfson Semiconductor Laboratory
RESEARCH ASSOCIATESHIP/FELLOWSHIP

Applications invited for this SERC funded post for work on modelling of metal-oxide-silicon transistors for very large-scale integrated circuits. The post will be attached to Wolfson Semiconductor Laboratory and will involve collaboration with Microelectronics Central Facilities set up by SERC. The basic aim of work will be to assess and validate short-channel transistor models available in CAD packages such as SPICE-2G and to set up instrumentation and develop software for parameter extraction for device and circuit design.

Applicants should have a good Honours degree in Physics or Electrical Engineering with suitable research and/or industrial experience.

Post tenable for two years but the grant may be further extended.

Salary will be either on the RF1A scale £6070-£10 575 plus superannuation or the Research Associate 1B scale £5285-£7700 plus superannuation. In either case the starting salary will be up to £6475 per annum subject to qualifications and experience.

Further particulars from Assistant Registrar (Sci & Eng), PO Box 363, Birmingham B15 2TT, to whom applications (three copies) including full curriculum vitae and naming three referees should be sent by Friday, 30 October, 1981.

Please quote ref: NSS3.

UNIVERSITY OF ST ANDREWS

Department of Psychology

Research Assistant: Cognitive Psychology

Applications are invited for a post of research assistant to work with Dr R. W. Byrna on a MRC Project "Geographical Knowledge and Orientation in the Blind". The successful applicant will conduct field and laboratory experiments on blind and sighted subjects in Fife and nearby counties, and subsequently collaborate in analysis and publication.

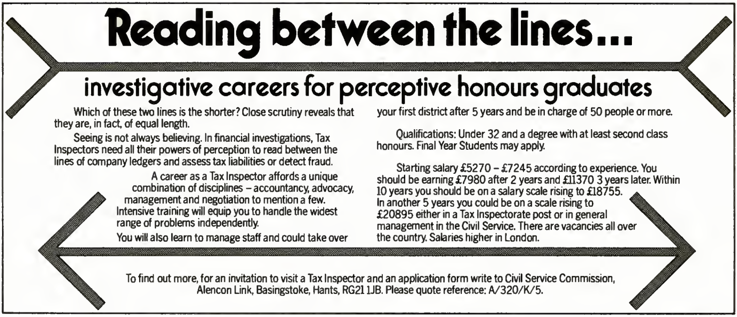
The appointment will begin in January 1982 or earlier, and last for 2 years. Starting salary £5285 per annum plus USS.

Applications (two copies preferably in typescript) with the names of three referees should be lodged by *30 October 1981*, with the Establishments Officer, The University, College Gate, St Andrews, Fife KY16 9AJ, from whom further particulars may be obtained.

KING'S COLLEGE LONDON
Research Technician Grade 3
A FIELD ASSISTANT

is required for studies in the Zoology Department to assist Dr D. M. Stoddart on the behavioural ecology of grassland rodents. The successful candidate will spend much time undertaking field work at the College Field Station in W. Sussex, and ideally should have had some experience of rodent field techniques. The appointment is funded by the NERC and is scheduled to run for two years and one month. Minimum qualification ONC or equivalent. Salary £5688 per annum (incl) rising to £5820 per annum (incl) after one year. Five weeks annual holiday. Superannuation scheme. Apply in writing, with curriculum vitae, including two referees, to: The Head Clerk (Ref: NS230903), King's College London, Strand, London WC2R 2LS. Closing date for applications, 10 October, 1981.

Reading between the lines...



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Which of these two lines is the shorter? Close scrutiny reveals that they are, in fact, of equal length.

Seeing is not always believing. In financial investigations, Tax Inspectors need all their powers of perception to read between the lines of company ledgers and assess tax liabilities or detect fraud.

A career as a Tax Inspector affords a unique combination of disciplines – accountancy, advocacy, management and negotiation to mention a few. Intensive training will equip you to handle the widest range of problems independently.

You will also learn to manage staff and could take over your first district after 5 years and be in charge of 50 people or more.

Qualifications: Under 32 and a degree with at least second class honours. Final Year Students may apply.

Starting salary £5270 – £7245 according to experience. You should be earning £7980 after 2 years and £11370 3 years later. Within 10 years you should be on a salary scale rising to £18755. In another 5 years you could be on a scale rising to £20895 either in a Tax Inspectorate post or in general management in the Civil Service. There are vacancies all over the country. Salaries higher in London.

To find out more, for an invitation to visit a Tax Inspector and an application form write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB. Please quote reference: A/320/K/5.

FERMENTATION SCIENTISTS/MICROBIAL PHYSIOLOGISTS PROCESS DEVELOPMENT

Celltech is a new British Company backed by both Government and City institutions which is dedicated to the exploitation of biotechnology through discoveries in the fields of recombinant genetics and cell fusion.
We are now looking for scientists to join a newly formed fermentation development department. Posts exist at several grades and applications are invited from experienced people with technical, graduate or doctoral qualifications in the fields of microbial physiology and fermentation technology.
Please send CV, quoting ref no. 116 to The Personnel Department, Celltech Limited, 250 Bath Road, Slough, Berkshire.

CELLTECH

MERSEYSIDE COUNTY MUSEUMS

ASSISTANT KEEPER

(INVERTEBRATE ZOOLOGY)

(£5652—£7137)

Applications are invited for this post, which is based at the County Museum, Liverpool. Candidates should have an interest in some aspect of invertebrate systematics and natural history and possess a degree in an appropriate subject and/or the Museums Association Diploma.

Application forms, returnable by 23 October, 1981, available from The Director, Merseyside County Museums, William Brown Street, Liverpool L3 8EN.

Merseyside County Council

THE UNIVERSITY OF SHEFFIELD

WOLFSON INSTITUTE OF BIOTECHNOLOGY

IMMOBILISED CELL TECHNOLOGY

Applications are invited for a postdoctoral fellow to work on a project on the immobilisation of plant cells which is part of an ongoing immobilised cell technology programme between UKAEA Harwell and the Wolfson Institute of Biotechnology. The successful applicant would spend the majority of his/her time based at Harwell, and would liaise closely with Wolfson Institute staff investigating natural product synthesis by immoblised plant cells. Applicants should have a background in the general area of biochemistry or microbiology; experience of cell culture or immobilisation techniques an advantage but not essential. Initial salary up to £6880 a year. Tenable one year with possible extension for a second year. Particulars from the **Registrar and Secretary, The University, Sheffield S10 2TN** to whom applications should be sent **by 12 October, 1981.** Quote ref: R633/H.

The Polytechnic of North London

Department of Electronic and Communications Engineering

SENIOR LECTURER/LECTURER II IN ELECTRONIC AND COMMUNICATIONS ENGINEERING

Applications are invited from graduates and/or Chartered Electrical Engineers for one of two posts. Candidates should be qualified to teach Electronics and Communications Engineering at BSc and Higher Diploma levels and able to supervise projects up to final year BSc level. Recent development experience in digital electronics and/or microprocessor systems and/or electronic production technology (pcb and thick film) will be a distinct advantage.

Salary Scales:
Senior Lecturer £9624—£11 328 (bar)—£12 141 plus £759 London Allowance.

Lecturer II £6462—£10 431 plus £759 London Allowance.

(Staff at the top of the Lecturer II scale can expect progression to the Senior Lecturer scale subject to satisfying an efficiency requirement)

Application form and further particulars from The Establishment Officer, Polytechnic of North London, Holloway Road N7 8DB.
Closing date for applications: 16 October 1981

UNIVERSITY OF STRATHCLYDE

Applications are invited for a post of

ANALYST

within the

DEPARTMENT OF PHARMACY

in conjunction with Pfizer Pharmaceutical Company. The appointee will be expected to have an honours degree in pharmacy/chemistry or other appropriate discipline and two years practical experience. Preference will be given to candidates having a higher degree and/or who can demonstrate expertise in gas and high pressure liquid chromatography.

Appointment will initially be for a period of one year, but may be extended to three years and will be on Range IA of the national salary structure for research and analogous staff. Commencing salary on the scale £6070–£6880 per annum, with placing according to age, qualifications and experience. USS benefit.

Written applications enclosing curriculum vitae and names and addresses of two referees (quoting R22/81) to: **Dr B. Caddy, Forensic Science Unit, Department of Pharmacy, University of Strathclyde, 204 George Street, Glasgow, by 7 October, 1981.**

CITY OF LONDON

Technical Analyst/ Programmers

COMPUTER APPLICATIONS IN ENGINEERING AND MATHEMATICS FOR THE MARINE, OFFSHORE AND HEAVY ENGINEERING INDUSTRIES.

Salaries £6,500 – £10,000

The Organisation

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There are excellent opportunities to work on a wide range of hardware (HP, DTC, DEC mini, IBM 3033N mainframe) and software (BASIC, FORTRAN IV, APL with TSO and SPF).

Vacancies

These are within the Computer Services Department to work on advanced applications of computers in the following areas:- • Finite Elements • Hydrodynamics and heat transfers • Graphics • Numerical Analysis Stability Theory • Machinery

Qualifications

Applications are invited from Honours Graduates in Applied Mathematics, Computing Science, Scientific or Engineering subjects with a minimum of 1 year's (or 2½ years' for the more senior positions) post graduate experience of computing relevant to engineering.

Please telephone 01-709 9166 ext. 301 or write for an application form to the Recruitment & Staff Relations Officer, marking the envelope "Confidential".

Lloyd's Register of Shipping

71 Fenchurch Street, London EC3M 4BS

PUBLIC HEALTH LABORATORY SERVICE BOARD

SENIOR GRADE MICROBIOLOGIST

Regional Public Health Laboratory, Manchester

Salary Scale £8134–£10 516.

Applications are invited from graduates with an immunological background, or from microbiologists with experience in immunology.

The person appointed will be responsible for running a research and development section within the Laboratory, and be expected to undertake both collaborative and independent research projects. He/she will also be expected to take part in the teaching and training of laboratory staff including the teaching of specialised advanced techniques and have responsibility for laboratory safety, with particular reference to the safety of new methods.

Applications, including full curriculum vitae and the names and addresses of three referees, should be sent to:

Dr D. M. Jones, Director, Public Health Laboratory, Withington Hospital, Manchester M20 8LR (Telephone: 061-445 2416).

MRC

Medical Research Council Centre

NEUROCHEMICAL PHARMACOLOGY UNIT RESEARCH TECHNICIAN

A RESEARCH TECHNICIAN

is required to carry out varied and interesting work in a multi-disciplinary unit concerned with the origins and treatment of mental illness. Previous experience of biochemical techniques, including the use of radioactive isotopes, would be an advantage. A relevant HNC, degree or equivalent qualification is necessary. Further training will be available in various aspects of neurochemistry, radio-immunoassay and immunohistochemistry techniques.

Salary on a scale £4677 to £6597 pa, depending on background and experience. The post is full-time (37 hours per week) but working times are negotiable with the scientist concerned.

Applications in writing, within the next two weeks, with CV and names of two referees, and quoting reference number NP/4 to: **The Administrator, MRC Centre, University Medical School, Hills Road, Cambridge CB2 2QH.**

ST BARTHOLOMEWS HOSPITAL, WEST SMITHFIELD, LONDON EC1

VIROLOGY DEPARTMENT

MEDICAL LABORATORY SCIENTIFIC OFFICER

A vacancy now exists for an MLSO to work in this busy department, which has both diagnostic and research commitments.

Applicants should either have passed the HNC examination in medical microbiology or hold an appropriate science degree.

The successful candidate will be encouraged to undertake further study leading to the IMLS Special examination.

Salary for MLSO: £5817–£7852 per annum inclusive of London Weighting.

Quote Ref: PTB/168.

Application form and job description from Personnel Department. Tel 01-600 9000 ext 2271.

ATLAS PRODUCTS AND SERVICES LIMITED
(A Burmah Company)

DEVELOPMENT CHEMIST

Required in our Agrochemicals Laboratory to develop formulations of pesticides as granules, suspension concentrates and emulsifiable concentrates and to oversee development from bench scale through pilot plant to full scale production. Some assistance with instrumental analysis for active ingredients will also be necessary.

Candidates should possess, at minimum, an HNC in Chemistry and should preferably have had experience in the formulation of pesticidal compositions.

Salary according to experience and in addition a good contributory pension scheme with free life assurance is available.

For an application form telephone or write to:

Mrs M. D. Malpas,
Atlas Products & Services Ltd.,
Fraser Road, Erith,
Kent, DA8 1PN
Telephone: Erith 32255

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Apply to: Colin MacKinnon, Talentmark Recruitment Consultants, King House,
11 Westbourne Grove, London W2 4UA. Tel: 01-229 2266 (24 hours)

Packaged Energy Research

Manchester

Join Chloride Technical of Swinton, the Research and Development Centre of the Chloride Group, and you'll be joining the world leader in the field of packaged energy. A company totally committed to the development of existing and new power systems.

These two positions in our Applied Research Department represent excellent opportunities to gain the highest professional and personal satisfaction at the forefront of the energy revolution.

METALLURGIST

—To manage development projects relating to new and conventional alloys, associated corrosion problems and new methods of sheet lead production.

You should have highly developed communicative skills and a good honours degree in Metallurgy, preferably with a PhD related to Electrochemistry.

ELECTROCHEMIST

—To manage development projects relating to conventional lead-acid or new battery systems.

A good honours degree in Chemistry or Electrochemistry preferably with a PhD in a related field.

Duties for both posts include the initiation, co-ordination and control of projects, through to supervision of prototype production and technology transfer to operating companies worldwide.

Some experience of the battery industry or an allied industry is desirable but not essential.

In addition to a competitive salary (within a salary range of £6575—£9030) negotiable according to experience, you'll enjoy excellent working conditions and the benefits of working for a major international Company. Realistic relocation expenses will be paid if appropriate.

Close to the M6, M61 and M62 motorways on the outskirts of Manchester, a wide variety of urban and rural housing, good schools and excellent recreational amenities are within easy access.

To find out more, telephone (reversing charges), send a full c.v. or write for an application form to John Edwards, Personnel Manager, Chloride Technical Limited, Wynne Avenue, Swinton, Manchester M27 2HB. Tel 061-793 5000.

CHLORIDE

DEPARTMENT OF CHEMISTRY

GRADUATE STUDIES IN CHEMISTRY

1981/82 ACADEMIC YEAR

Applications are invited from candidates with high academic records who wish to pursue further studies towards the MSc and PhD Degrees in Chemistry. Excellent research facilities are available in all areas of modern Chemical Science, ranging from Bio-Inorganic Chemistry to Chemical Physics. Teaching and research assistantships are available for all students in the programme. The total minimum stipend is $9000 for MSc students, with higher amounts for PhD students and holders of graduate scholarships.

Application forms and further particulars may be obtained from: **James Trotter, Professor and Acting Head, Department of Chemistry, The University of British Columbia, 2036 Main Mall, Vancouver, BC, Canada V6T 1Y6.**

INSTITUTE OF CANCER RESEARCH

A RESEARCH OFFICER

is required to work on a CRC/MRC funded project concerned with the application of recombinant DNA technology to problems in mammalian developmental biology. Enthusiasm is as good a qualification as previous experience in either of these fields. Starting salary in range £5283-£5739 per annum plus London Allowance of £859 per annum.

Applications in duplicate with the names of two referees should be sent to the Secretary, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting ref 301/B/8.

NORTHERN REGIONAL HEALTH AUTHORITY
REGIONAL MEDICAL PHYSICS DEPARTMENT
FREEMAN HOSPITAL UNIT
INSTRUMENTATION IN MEDICINE

PHYSICIST/ ENGINEER

Required to join a team of physicists and engineers applying scientific, measurement, instrumentation and computing skills to medical problems. He/she will be expected eventually to lead projects from their initial inception and discussion to their completion and assessment. A keenness to acquire electronic instrumentation and computing expertise is essential. There will be particular emphasis, in this post, towards clinical and research work in Urology.

Freeman is a new hospital with excellent general and Medical Physics facilities.

Applicants should have a good honours degree in Electrical/Electronic Engineering or Physics.

Salary scale £5667—£6745.

Application form and job descriptiona vailable from Regional Personnel Officer, Northern Regional Health Authority, Benfield Road, Newcastle upon Tyne NE6 4PY. Applications should be made within 14 days.

UNIVERSITY OF SURREY

Department of Mechanical Engineering

Applications are invited for two appointments financed jointly by the SERC and UK AERE, Harwell as:

RESEARCH FELLOWS

to work with Dr I. P. Castro on a project entitled "Highly Turbulent Flows with Regions of Recirculation". Applicants with postgraduate qualifications and research experience in either experimental or computational fluid mechanics are sought.

Salary will be in the range IA of the Research & Analogous staff scale up to £8515 per annum initially, according to age and experience, with superannuation under USS. Both posts are available from January 1982 for two years.

Applications in the form of a curriculum vitae (3 copies) including the names and addresses of two referees should be sent to the Deputy Secretary (Personnel), University of Surrey, Guildford, Surrey GU2 5XH, quoting reference 47 NS. Further information can be obtained from Dr Castro on Guildford 71281 ext. 758.

MRC

Medical Research Council Centre

CLINICAL ONCOLOGY AND RADIOTHERAPEUTICS UNIT

A RESEARCH ASSISTANT

is required to join a group working on clinically applied cancer research. The person appointed would work initially on the metabolism and distribution of anticancer drugs, both in patients and experimental models.

Applicants should have a relevant degree or HNC. Experience in drug analysis or experimental chemotherapy would be useful but is not essential.

Salary on a scale from £4677 pa depending on background and experience.

Applications in writing by 9 October, 1981, with CV and names of two referees, and quoting reference number CO/6, to: **The Administrator, MRC Centre, University Medical School, Hills Road, Cambridge CB2 2QH.**

THE ROYAL SOCIETY OF CHEMISTRY

EDITORIAL STAFF

A Chemistry Graduate is required for editorial work on the Society's publications. A good degree or equivalent in chemistry is essential, and a proven ability to write in clear concise English will be an asset.

Further particulars and application forms may be obtained from:–
Mrs S. M. Sheldon Assistant Personnel Officer, The Royal Society of Chemistry, 30 Russell Square, London WC1B 5DT
Telephone: 01-631 1355
Closing date: 30 October, 1981.

LABORATORY TECHNICIAN (GRADE 5)

required in Department of Food Science, University of Reading to work on an ARC research project on the flavour of milk and milk products. Main techniques involved will be preparation of extracts and their gas chromatography. Background in chemistry, physics and/or electronics sought and HNC or equivalent qualification or experience. Three year fixed term appointment. Salary in scale £5695-£6650 pa. Application form available from Personnel Office, University of Reading, Whiteknights, Reading RG6 2AH. Please quote Ref. T.21A.

Unit Head

Gas Chromatography Mass Spectrometry

We wish to appoint a Scientist to be responsible for all analytical work involving gas chromatography and mass spectrometry. The successful applicant is likely to be a graduate with several years experience of developing analytical methods. Familiarity with quantitive gas chromatography and mass spectrometry is essential. A knowledge of capillary gas chromatography and data handling techniques would be an advantage, as would an appropriate Ph.D. qualification.

The salary offered will reflect the experience and qualifications of the successful candidate. Benefits of employment include flexible working hours, a subsidised restaurant, sports and social facilities and pension scheme.

Please apply in writing to Mr. R. A. Cowie, or telephone 01-592 3060 extension 2506, for an application form.
Please quote reference 00363R/NS.

M&B May&Baker

May & Baker Ltd., Rainham Road South,
Dagenham, Essex RM10 7XS

Brown Boveri Research Center, Baden/Switzerland

We have an open position for an *experimental physicist* in the field of

surface physics

Requirements: PhD and research experience in physics of surfaces and interfaces. Knowledge in electrochemistry. Ability to make active contribution to the definition of future research programs.

We offer: Possibility to carry own research responsibility in small team. Close interaction with solid state physicists, electrochemists and theoretical physicists. Modern and well equipped experimental facilities.

Interested and suitably qualified applicants should send a written application together with the necessary personal information under reference number 289/14/93 to Mr Lengen, Personaleinstellung PDE-A.

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Warren Spring Laboratory, Stevenage
Department of Industry

Chemist

. . . to join a small group in the Oil Pollution Division engaged in studies of the physical processes associated with the dispersion of hydrocarbons and similar substances in the sea, and the mechanisms of formation and demulsification of water/oil emulsions. Work includes the co-ordination and direction of field studies, in close association with oil companies and local authorities. This will involve periods at sea in the Department's vessel "Seaspring".

Candidates, normally aged under 30, should have a degree or equivalent in chemistry, preferably physical or industrial, and at least 2 years post-qualification experience.

Appointment as Higher Scientific Officer (£6530—£8585) or Scientific Officer (£5175—£6960). Level of appointment and starting salary according to qualifications and experience.

For further details and an application form (to be returned by 23 October, 1981) write to Mrs J. M. Smith, Warren Spring Laboratory, Gunnels Wood Road, Stevenage, Herts SG1 2BX. *Please quote ref: SA/58/MF.*

Aerodynamicist

. . . to join a group within the Air Pollution Division, using well equipped wind-tunnels to study the dispersion of air pollution. Work includes basic research, and ad hoc studies carried out under contract to industry and public bodies, on such problems as the effects of buildings and topography, accidental escapes of dense and light gases, and dust dispersion.

Candidates, normally aged under 30, should have a good honours degree in Mechanical or Aeronautical Engineering or Physics and preferably at least two years subsequent experience. An understanding of theoretical and experimental Fluid Mechanics/Aerodynamics, and knowledge of modern instrumentation methods, including the use of computers, would be advantageous. Some knowledge of atmospheric pollution problems would be useful.

Appointment as Higher Scientific Officer £6530—£8585 or Scientific Officer £5175—£6960. Level of appointment and starting salary according to qualifications and experience.

For further details and an application form (to be returned by 23 October, 1981) write to Mrs J. M. Smith, Warren Spring Laboratory, Gunnels Wood Road, Stevenage, Herts SG1 2BX. *Please quote ref: SA/57/MF.*

Employment Medical Advisory Service
Health & Safety Executive

Chemist/Biochemist

. . . to join a London-based unit responsible for the scientific appraisal and interpretation of data about substances possibly giving rise to occupational health risks. Work of the post includes: assessing the scientific validity of data made available to the unit: checking the accuracy of presentation of data and identifying errors and omissions; retrieving data from all available sources; preparing summaries of data for use within the unit and reducing this material for computer storage; liaising with other HSE staff on chemicals appraised by the unit.

Candidates, normally aged under 27, should have a good honours degree or equivalent in chemistry, biochemistry or a related subject. Knowledge of toxicology and an interest in information science would be advantageous.

Appointment as Scientific Officer £6190—£7980 with starting salary according to qualifications and experience.

For further details and an application form (to be returned by 23 October 1981) write to Mrs G. Dineen, Health and Safety Executive, CS (Personnel Management) 1B, Baynards House, 1 Chepstow Place, London W2 4TF. *Please quote ref: SA/26/PB.*

Scientific
Civil Service

Senior Technicians

Pharmacology Department

c £6000 Beckenham, Kent

The Wellcome Foundation Limited is the British based parent company of an international group of pharmaceutical and chemical companies concerned with the discovery, development, manufacture and distribution of products to promote the health and hygiene of humans and animals.

We wish to appoint two technicians to join a team using isolated tissues to study neuro transmitter mechanisms for evaluating the autonomic effects of potential therapeutic substances produced within the company. You will have studied pharmacology to HNC or degree level and will have some relevant experience ideally of radiochemical tracer techniques.

The Research Laboratories are set on an attractive estate which is within easy reach of both Central London and the Kent countryside. Our exceptional benefits package includes five weeks' holiday, flexible working day, life assurance, sick pay and pension schemes, subsidised restaurant, first class sports and social facilities and generous assistance with relocation expenses where appropriate.

For an application form please ring our automatic telephone answering service on 01-650 6541, giving your name and address and quoting reference number WRL/153. Alternatively, write to Mr A. G. Murdoch, Personnel Officer, The Wellcome Research Laboratories, Langley Court, Beckenham, Kent BR3 3BS.

Wellcome

INFLAMMATION RESEARCH

Post-Doctoral Pharmacologist or Biochemical Pharmacologist

We have a vacancy for a pharmacologist or biochemical pharmacologist in our R & D Laboratories in Leicestershire. The position is for a senior member of a team investigating pharmacological and cellular mechanisms in chronic inflammatory diseases. The work is directed to the discovery of new compounds of potential therapeutic value.

Applicants (m/f) should hold a first degree in pharmacology, biochemistry or cell biology with preferably PhD and post-doctoral experience in the field of inflammation.

Conditions of employment include a competitive salary, flexible working hours, an active Sports & Social Club, pension facilities and assistance with relocation where appropriate. We can offer pleasant rural surroundings with relatively low cost housing, also access to major Midland cities.

Please phone or write for an application form to Miss Cathy Mason, Personnel Officer, R & D Laboratories, Fisons Limited, Pharmaceutical Division, Bakewell Road, Loughborough, Leicestershire. Please quote reference number RD134/NS

FISONS
PHARMACEUTICAL DIVISION

UNIVERSITY OF OXFORD DEPARTMENT OF ENGINEERING SCIENCE

Robot Welding and Computer Aided Manufacture

Applications are invited for two new research posts:

(a) Robot Welding

An interdisciplinary research group was formed in February, 1981 with joint support by SERC and BL Technology Ltd., to study sensory control of arc welding robots. This group is now being expanded by addition of a new post which will provide a unique opportunity for a young engineer to develop the technology of an exciting new field.

This engineer is required to design and build special equipment for robot sensors and controllers, and will have expertise in electronics as well as some experience of micro hardware and software.

(b) Computer Aided Manufacture

A Research Assistant is required for a SERC funded project, in collaboration with the Computer-Aided Design Centre, Cambridge, concerned with further developments of a geometric modelling system for the computer-aided manufacture of dies and moulds. Applicants should have a good honours degree in Engineering, Science or Mathematics and preferably, experience of computing and/or numerically controlled machine-tools. The successful applicant may be permitted to register for a higher degree.

The posts are superannuable and on incremental scales £6070 to £10 575 (Grade 1A). Applications, including a curriculum vitae naming two referees should be sent to:—

The Administrator, Department of Engineering Science, University of Oxford, Parks Road, Oxford OX1 3PJ, from whom further details may be obtained. Closing date 12 October, 1981.

THE ANIMAL VIRUS RESEARCH INSTITUTE

invites applications for a post in the Tissue Culture Production Unit. The person appointed must have experience of large-scale preparation of tissue cultures and appropriate biological fluids and some experience of virological assays with tissue cultures is also desirable. He/she will be responsible to the officer in charge of the Unit and the duties will include some supervision of the day-to-day work programme which is carried out by a group of 8 supporting staff. Candidates should possess a Degree, HNC, MI Biol. or equivalent. The post is in the Scientific Officer grade (£5176-£6964) starting salary depending on age and qualifications.

A house may be available for a married applicant. There is a non-contributory superannuation scheme.

Application forms and further particulars from Secretary, AURI, Pirbright, Woking, Surrey GU24 0NF. (Tel. Worplesdon 232441), during office hours.

City and Hackney Health District
RENAL UNIT
St Leonard's Hospital, London N1

RESEARCH ASSISTANT

Required to assist in research into fluid shifts of patients with kidney failure by artificial kidneys.

Applications are invited from either new or experienced science graduates. Salary according to qualification and experience.

Funding available for one year only initially.

For further information and application form, contact the **Personnel Department, St Bartholomew's Hospital, EC1. Telephone: 01-600 9000 ext 320 quoting ref RP/RU.**

Natural History Editors

Usborne Publishing are urgently seeking freelance and full-time staff editors to work on their highly successful natural history books for children

The work will involve not only editing, but also research, page layout, writing final copy, and briefing authors, designers and illustrators

The ideal applicant would have a degree in one of the natural sciences and at least two years' experience in publishing

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Please write to:

Sue Jacquemier,
Usborne Publishing,
20, Garrick Street,
London WC2E 9BJ
Tel. 01-379 3535

Fluid Dynamics

Wind loads on structures
Vortex-induced oscillations
Wave loads on offshore structures

Extracts from the notebook of Leonardo De Vinci (1452-1519)

Atkins Research and Development are leading consultants in these technical areas and are rapidly developing their business in the UK and overseas. We wish to appoint a fluid dynamicist who is keen to build up a reputation in bluff body fluid dynamics, including the topics listed above. The successful candidate will have a first rate academic record and probably some experience in the application of such knowledge to practical engineering situations.

The company encourages staff to develop their expertise and participate in research activities as well as satisfying the needs of clients in a wide range of technically advanced industries.

The work is demanding but the candidates will receive full support from an expanding team of professional staff in the Dynamics Department. The remuneration will reflect the demands of the post. Generous removal allowances will be paid where applicable. Atkins Research and Development are part of the WS Atkins Group, one of Europe's largest management and engineering consultancies and offer excellent career prospects.

Please write giving details of experience to G J Dempsey, Personnel Adviser, Atkins Research & Development, Woodcote Grove, Ashley Road, Epsom, Surrey KT18 5BW or telephone Epsom 26140, extension 2676 for an application form.

Atkins Research and Development

1980

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ELECTRONICS TECHNICIAN GRADE 5

required in Computer Centre to be responsible for maintenance of VDU's and the expanding communications network linking departments to the central computer. Three year appointment in the first instance. HNC or equivalent desirable, experience with microprocessors an advantage. Salary in scale £5695-£6650 pa. Application forms are available from Personnel Office, University of Reading, Whiteknights, Reading RG6 2AH, telephone (0734) 85123 ext. 448. Please quote Ref. T.20B.

SURREY AREA HEALTH AUTHORITY

East Surrey District & Crawley Pathology Service

JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICERS

for Departmelts of Microbiology & Haematology. Applicants should possess appropriate degrees in Microbiology, Biology or Zoology.

Application forms from Principal MLSO, Redhill General Hospital, Earlswood Common, Redhill, Surrey.

PHYSIOLOGICAL MEASUREMENT TECHNICIAN

(qualified) required at the Royal National Hospital for Rheumatic Diseases to be based in the Clinical Research Department. Post funded from research grant until June 1983. Knowledge of computer techniques an advantage. £3498 per annum rising to £4476 per annum. Send SAE for application form and job description to Hospital Administrator, RNHRD, Upper Borough Walls, Bath. Closing date 8 October.

GUY'S HOSPITAL MEDICAL SCHOOL

GRADUATE RESEARCH ASSISTANT (Statistician)

required in the Unit for Metabolic Medicine until 30 September, 1983, to assist researchers in analysis of date. Salary in range £5285–£7700 plus £967 London Allowance.

Apply in writing, with full curriculum vitae, to the Secretary, Guy's Hospital Medical School, London Bridge SE1 9RT, quoting Ref: MM.

FBC

FBC Limited, Britain's leading agrochemicals enterprise, is owned by The Boots Company Limited and Fisons Limited. It combines the assets and long experience of both Companies in agrochemicals and certain of Fisons interests in industrial chemicals.

Our Research and Development Centre is based at Chesterford Park, near Saffron Walden, Essex, where the facilities are amongst the best in the world.

We have the following opportunities, which are open to men and women.

Senior Chemistry Technician

to join a research team involved in the synthesis of new compounds for the public health field.

You should be qualified to HNC level in chemistry with practical experience in organic synthesis.

Chemical Information Officer

to join a team organising information systems and advising on the novelty and patentability of compounds under consideration for synthesis by our research chemists.

You should be qualified to Honours degree level in chemistry, and experience in information work and knowledge of WLN and on-line systems would be advantageous.

We offer a competitive salary supported by a substantial range of fringe benefits, including assistance with relocation expenses where appropriate.

Please write with full details of your career to date, including current salary, to: Peter England, Personnel Officer, FBC Limited, Chesterford Park Research Station, Saffron Walden, Essex CB10 1XL.

UNIVERSITY COLLEGE CARDIFF

DEPARTMENT OF ZOOLOGY

RESEARCH ASSISTANT

Applications are invited for the above post to work on Flight Behaviour of Bean Aphids. Applicants should have an honours degree in Biology or a related subject. The post is for a fixed term of two years and the salary range is £5285—£5675 p.a. Duties to commence as soon as possible.

Applications (2 copies) together with the names and addresses of two referees should be forwarded to the **Vice-Principal (Administration) and Registrar, University College, PO Box 78, Cardiff CF1 1XL, from whom further details will be available. Closing date 30 October. Ref: 2287.**

THE POLYTECHNIC OF NORTH LONDON

Department of Chemistry

Re-advertisement:

LABORATORY TECHNICIAN GRADE V

CHROMATOGRAPHY TECHNICIAN

A technician is required urgently for work in the specialist laboratories of the Department. Substantial experience in the application of chromatographic techniques in research and analysis is essential. Ref 4/81.

Applicants should preferably hold at least HNC or an equivalent qualification and have eight years' experience, inclusive of the training period.

Salary scale: £6711-£7666 inclusive of London Weighting.

For further details and an application form contact the Head of the Department of Chemistry, Polytechnic of North London, Holloway Road, London N7 8DB.

Break Out!

Confined in your present post? Would you like to:

- Get out and meet people more, using your scientific background to the full?
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You could do this—as a Technical Services Representative—visiting laboratories, hospitals, etc., and discussing products on a technical basis. The work is demanding but satisfying.

You would have an attractive salary and car, and other excellent benefits.

For our free information leaflet, phone Chris Barringer on 01-221 5222 or write (no stamp needed):

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LINCOLNSHIRE & SOUTH HUMBERSIDE TRUST
for Nature Conservation

GIBRALTAR POINT WARDEN

Applications are invited for this challenging new appointment which carries responsibilities for the running of a well known coastal Nature Reserve, Field Station and Visitor Centre. Abilities are sought in nature conservation, education and administration.

Salary in range £4150—£4550 plus free accommodation.

Send sae for further details to L & SHTNC, The Manor House, Alford, Lincolnshire LN13 9DL

MEDICAL REPRESENTATIVES

Experienced and Life Science Graduates, 23/35. Many vacancies. Excellent career positions. Top salary + car + good incentives. Please telephone or write to:-

Bishopsgate Employment Agency, Ridgeway House, 41 King William Street, London EC4R 9EN. 01-623-3912.

Research Assistant in Bioengineering

A Graduate Mechanical Engineer, preferably with Bioengineering training or experience, or with comparable academic status, is required for the Orthotic Research and Development Unit Institute of Orthopaedics, Stanmore.

The Unit is involved in the development of improved orthoses (orthopaedic splints and braces) and in some teaching of Orthotics and related Biomechanical Engineering.

Salary Scale: £5285 to £7700 plus £967 London Weighting according to age and experience.

Opportunity (and preference) for study for higher degree.

Application forms and further details from: The Institute Secretary, Institute of Orthopaedics, Brockley Hill, Stanmore, Middlesex.

Merton, Sutton & Wandsworth Area
Health Authority (Teaching)
Roehampton Health District
Queen Mary's Hospital
Roehampton SW15

Department of Medical Microbiology

MEDICAL LABORATORY SCIENTIFIC OFFICER

or Junior 'B' MLSO required for routine diagnostic microbiology laboratory. MLSO candidates should be state registered. Junior 'B' MLSO candidates should hold ONC or TEC (MLS) or an appropriate degree or suitable science GCE 'A' level passes with an intention to specialise in Medical Microbiology. MLSO salary £4958—£6993 + LWA £859. Junior 'B' MLSO £3120—£4350 pa.

For more details please contact Chief MLSO on 01-789 6611 Ext. 427. Application forms from the Personnel Department.

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REGULATORY AFFAIRS

Pharmaceuticals **Based Maidenhead**

Wyeth Europe is the European coordination group of Wyeth International a major division of American Home Products Corporation. Its operating companies are responsible for the research, development, registration, manufacture and marketing of a wide range of ethical pharmaceutical and nutritional products, with an unbroken record of successful growth.

We are looking for a

PRODUCT LABELLING EXECUTIVE

to join a small team of Regulatory Affairs specialists within our Research and Development division. In liaison with other departments the job holder will have special responsibility for the development of text for labels and package inserts for European markets and many other overseas markets. The position also offers the opportunity to gain experience in an International Regulatory Affairs Coordination group.

The position is likely to suit a life sciences graduate preferably with 1-2 years' experience in the pharmaceutical industry. Some linguistic ability would be an asset. The ability to produce good written material and to work logically but creatively within systems for control and coordination of pharmaceutical disciplines is essential.

Salary and benefits are competitive with excellent working conditions.

Please write in confidence giving full details of career and salary progression to:-

Miss M. O'Shea,
Personnel Manager,
Wyeth Europa Limited,
Remax House,
31/32 Alfred Place,
London WC1E 7DS

Wyeth

The National Hospitals for Nervous Diseases
Queen Square, London WC1

Temporary Electron Microscopy Technician

Required immediately for an initial period of 6 months while the present holder of the post is on maternity leave. Experience and a high degree of competence is essential. Familiarity LKB. ultra-microtomes and Jeol electron microscope preferable Salary dependent on qualifications and experience. On the Whitley Council MLSO grade (£4958—£6993 pa plus £839 London Weighting Allowance). 37 hour week, 5 day week.

Written applications, stating experience and names and addresses of two referees to Personnel Officer at above address.

The National Hospitals
For Nervous Diseases

NH
ND

Science Technician

£5547 - £6009 pa inc

An interesting opportunity to work at the Polytechnic's attractive Trent Park, Cockfosters location in north London, providing technical support to staff and students using the science laboratories.

Responsibilities include the preparation of laboratories and materials, assisting with demonstrations, and the maintenance of equipment and materials stocks.

Relevant laboratory experience with students up to 'A' level standard in Chemistry or Biology is expected, together with appropriate qualifications.

Write quoting ref C318A for further details and an application form, posting first-class to: Personnel Office, Middlesex Polytechnic, 114 Chase Side, London N14 5PN. Closing date 12 October.

Middlesex Polytechnic

Operational Research

Central London

The Civil Aviation Authority is an independent public body responsible for economic, technical, operational and safety aspects of British civil aviation.

The Authority has a vacancy for a Scientific Officer to join a small group making analytical studies and mathematical models of safety problems, and helping line management on statistical matters. The problems cover a range of topics in the field of civil aviation. They currently include: air traffic separation standards; radar and navigation equipment performance; social surveys related to aircraft noise; obstacle clearance; North Sea helicopter operations, etc. Some of the work is conducted on an international scale, with the opportunity to collaborate with experts from other countries.

Applicants should possess a good honours degree in a numerate science with strength in mathematics and statistical modelling. A post-graduate qualification in Operational Research would be a distinct advantage.

Salary, inclusive of London Weighting will be in the range of £6,590 – £8,500 depending on qualifications and experience. Conditions of service include four weeks annual leave, an excellent pension scheme, luncheon vouchers and an interest free season ticket loan.

CAA

For an application form write to or telephone:
Miss S White, Civil Aviation Authority
Personnel, Room T1110, CAA House,
45-59 Kingsway, London WC2B 6TE.
Tel: 01-379 7311 Ext. 2399. Completed application forms should be returned by 21 October 1981.

THE UNIVERSITY OF LEEDS
DEPARTMENT OF APPLIED MATHEMATICAL STUDIES

Applications are invited for a post of

Postdoctoral RESEARCH FELLOW

for work on aerodynamic sound generation by surface roughness, under the direction of Professor D. G. Crighton, involving the use of analytical and numerical techniques in fluid mechanics and wave propagation. The appointment will be made from a date to be arranged for a fixed period of up to two and a half years.

Applicants should have a PhD in an appropriate area of Applied Mathematics, Physics or Engineering.

Salary on the IA Range for Research and Analogous Staff (£6070-£10 575), according to age, qualifications and experience.

Informal enquiries may be made to Professor D. G. Crighton (Telephone Leeds (0532) 31751 ext. 7304).

Application forms and further particulars may be obtained from the **Registrar, The University, Leeds LS2 9JT,** quoting reference number 51/11/E. Closing date for applications **23 October 1981.**

BIOCHEMIST

Leukotriene/ Prostaglandin Biosynthesis

We require a PhD or biochemistry graduate with 2-3 years' relevant experience to study and isolate enzymes involved in the generation of lipoxygenase/cyclo-oxygenase products in allergic diseases.

The candidate would be required to initiate and develop this research programme and would join a team of biologists and chemists already working in this field. An interest in drug candidate identification would be an advantage.

For details of our excellent conditions of employment and an application form, telephone Farnham Common 5151.

Personnel Department, Miles Laboratories Ltd., Stoke Court, STOKE POGES, Bucks SL2 4LY.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

Energy Conservation Technology

The Energy Technology Support Unit (ETSU) acts on behalf of the Departments of Energy and Industry in stimulating and managing programmes of research, development and demonstration on energy conservation which are carried out in industry, universities and other government laboratories. The work currently in hand involves both the wider application of known technologies and the research and development of improved processes and techniques.

We would like to expand the team driving forward these important national programmes by recruiting experienced graduate Scientists and Engineers in their mid twenties to early thirties with industrial experience and the ability to communicate effectively at the most senior management levels. A limited number of vacancies also exists for young post doctoral researchers without industrial experience who can demonstrate an ability to think logically and critically through the complexities of all phases of technical innovation.

These are permanent appointments with long term career prospects either in this area or in the wider context of the Authority's other research and development programmes, but fixed term appointments may also be possible. Starting salary, on a scale rising to £11,000 will be dependent on age and experience.

For an application form and further details write on a postcard, quoting ref. AQ.21 to: Kim Sexton, Recruitment Branch, AERE Harwell, Oxon OX11 0RA. Tel: (0235) 24141. ext. 2058.

HARWELL

UNIVERSITY OF OXFORD

Department of Agricultural and Forest Sciences: Reproductive Biology

Applications are invited for a postdoctoral (or otherwise experienced)

RESEARCH ASSISTANT

to continue for a third year an investigation under laboratory conditions of prenatal mortality and the endocrine control of implantation in the vole, bank vole and wood mouse. The project, under the direction of Dr John Clarke, is supported by a grant from the Nuffield Foundation. Salary on 1A scale (£6070-£10 575). Applications, including curriculum vitae and names of two referees, to be sent by Monday, 2 November to the Administrator, Department of Agricultural and Forest Sciences, Parks Road, Oxford OX1 3PF.

DESK EDITOR

Required for work on specialised scientific journals in a rapidly expanding company. A concern for literate communication and a good command of the English language are essential, as is the ability to work precisely and thoroughly under pressure. Applicants should have had university level training in the Physical Sciences or Engineering.

The work entails the copy-editing of manuscripts and correction of proofs. The desk editor liaises with Academic Editors and authors as well as with our production department in Lausanne.

Application forms can be obtained by ringing Oxford 511385 or applications (handwritten) may be sent to: **The Office Manager, Editorial Office (UK) of Elsevier Sequoia, Mayfield House, 256 Banbury Road, Oxford OX2 7DH.**

RESEARCH TECHNICIAN IN BIOCHEMISTRY

We have a vacancy for a research technician in the Department of Biochemistry at our R & D Laboratories in Leicestershire. The vacancy is in a small team working in the field of inflammatory disorders. The work is varied and is directed towards the discovery of new compounds of therapeutic value.

Applicants (male/female) will preferably be qualified to HNC/HND level with some experience in biochemistry.

Conditions of employment include a competitive salary, flexible working hours, an active Sports & Social Club, pension facilities and assistance with relocation where appropriate. We can offer pleasant rural surroundings with relatively low cost housing, also access to major Midland cities.

Please phone or write for an application form to Miss Cathy Mason, Personnel Officer, R & D Laboratories, Fisons Limited, Pharmaceutical Division, Bakewell Road, Loughborough, Leicestershire. Please quote reference number RD133/NS.

FISONS 1975

PHARMACEUTICAL DIVISION

PUBLIC HEALTH LABORATORY SERVICE BOARD CENTRAL PUBLIC HEALTH LABORATORY

Streptococcus Reference Unit,
Division of Hospital Infection

BASIC GRADE MICROBIOLOGIST

Probationary Salary Scale £5686–£7302 inclusive of London Weighting.

There is a vacancy for a graduate in the Streptococcus Reference Unit at Colindale, London. The work of the Unit currently includes typing of streptococci isolated from outbreaks of disease, the serological diagnosis of infections caused by streptococci and identification of strains isolated from cases of serious disease.

Interested candidates who would like to discuss this appointment may do so by arrangement with Dr G. Colman, telephone 01-205-7041 ext. 221.

Salary according to age, qualifications and experience on the NHS Whitley Council Scientific scale as above.

Applications to Personnel Officer, Central Public Health Laboratory, Colindale Avenue, Colindale, London NW9 5HT. Telephone 01-205-7041. Closing date 6 November, 1981.

ST THOMAS' HOSPITAL

Lambeth Palace Road,
London SE1 7EH

COMPUTER BASED INSTRUMENTATION FOR CARDIOLOGY

A graduate is required to join a Bioengineering group developing on-line mini-computer based instrumentation for clinical cardiology and cardiac research. The post involves the development of both hardware and software.

A first degree in electronic engineering or physics with electronics would be preferred.

This post is on the basic grade medical physicist scale in the range £6526-£7604 inclusive, for a graduate with a 1st or 2nd class honours degree. The appointment will be for one year in the first instance. Further details and application forms are available from the Personnel Department, 01-928 9292, ext 2422.

MEDICAL PHYSICS TECHNICIAN III

ST. GEORGE'S HOSPITAL

Blackshaw Road, Tooting, SW17

A person is required to design and make a wide range of electronically based medical development and research instruments using both analogue and digital techniques.

Minimum qualifications are ordinary TEC or equivalent in an appropriate subject. Normally a higher level of qualification will be accepted. At least two years relevant experience is necessary. However, persons with less experience may be considered for appointment as a grade IV.

Salary scale MPT III £5563–£7155
MPT IV £4668–£6137
London Weighting £859 per annum.

Requests for application forms and formal job description should be made to: Mr R. W. Burton, Assistant Administrator, St. George's Hospital, Blackshaw Road, SW17. Tel: 01-672 1255 Extension 4488.

For further details of the post contact: Mr D. Ritchie, Chief Electronics Technician. Tel: 01-672 1255.

FOOD AND ASSOCIATED INDUSTRIES

For UK vacancy list within Research/Product-Process Dvpt/, Q.C., Production/Engin'g Management, etc.

(£6000—£12 000)

phone SENIOR PERSONNEL APPOINTMENTS 0782-29914/29467

ACOUSTICS AND STRUCTURAL DYNAMICS

Since its formation in May 1980 Arup Acoustics has attracted interesting work. Current commissions in the UK include a review of the acoustics of the Royal Festival Hall, speech reinforcement in Canterbury Cathedral, advice to the National Theatre Company, redevelopment at Alexandra Palace and at the Royal Exchange, IBM Offices Southbank, and a range of work relating to noise and vibration control in industry, civil engineering and building services. Overseas current projects include the new Hongkong and Shanghai Bank Headquarters in central Hong Kong, a stadium at Kano Nigeria, scientific research facilities in Kuwait and smaller projects in France, Germany and Eire.

The practice is small and now needs one or two more staff. Engineering Graduates with some practical experience—particularly anyone with experience of building vibration—are invited to write to Professor Peter Parkin, Arup Acoustics, quoting ref AAC81/2 and giving a brief account of their qualifications and experience.

OVE ARUP PARTNERSHIP

13 Fitzroy Street, London W1P 6BQ

GLASSHOUSE CROPS RESEARCH INSTITUTE

VACANCY FOR HEAD OF PLANT PATHOLOGY AND MICROBIOLOGY DEPARTMENT

Experienced scientist required as Head of Department formed by combining existing Microbiology and Virology Departments already within the Crop Protection Division to help develop in collaboration with the Head of Division a fully integrated programme of crop protection research and also to pursue personal research. Particular emphasis will be placed on epidemiological studies and to integrated pest and disease control systems, extending as appropriate to collaborative programmes with other establishments. The Division comprises 60 staff in addition to the Head, 33 of whom will make up the combined Department.

Applicants should have a good Honours Degree, with a substantial research record in Plant Pathology and Microbiology and the ability to provide innovative scientific leadership.

Appointment in the Senior Principal Scientific Officer grade (£14 329-£17 418 pa). Non-contributory superannuation scheme.

Further details and application forms from Institute Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Littlehampton, West Sussex BN16 3PU, by 9 October, 1981.

ROTHAMSTED EXPERIMENTAL STATION
HARPENDEN, HERTS AL5 2JQ

DOCUMENTATION ASSISTANT

required in the Insecticides & Fungicides Department to join a team of chemists and biologists working on the development of new insecticides related to the natural pyrethrins. The work will be closely integrated with the experimental programme and include classifying documents and patents related to recent discoveries, library searches and use of computers. An interest in chemistry or biology would be advantageous. Temporary post for two years, funded by the British Technology Group (National Research Development Corporation).

Minimum qualifications: 4 'O' levels, grades A, B or C but preference given to candidates with 'A' level Chemistry or Biology.

The post is in the grade of Assistant Scientific Officer. Salary at age 18 £3336 pa; at age 21 or over £4130 pa, with an annual increment. Non-contributory superannuation.

Four weeks leave. Canteen. Varied sports and social facilities.

Apply in writing to the Secretary quoting Ref 45/81 by 8 October, 1981.

Analytical development Section Leader.

We're Sterling-Winthrop, one of the leading manufacturers of ethical and proprietary medicines in the UK. We're firmly committed to Research & Development and in March 1982, we're opening a brand new, purpose-built Research Centre in Alnwick, Northumberland.

We wish to appoint a Section Head to lead a team of scientists involved in the development of both new and improved analytical procedures for a wide range of ethical, proprietary and household products. Responsibilities will include the resolution of analytical problems associated with PL and CTC applications, provision of a non-routine analytical service and the planning and progression of all project work within the group.

The successful applicant must have an honours degree or equivalent qualification and preferably a higher degree in either Chemistry or Analytical Chemistry. Several years experience of analytical method development in the pharmaceutical or allied industry are essential, together with a detailed knowledge of HPLC and GLC. Experience of the statistical treatment of analytical data and the development of automated methods of analysis including dissolution testing would be an advantage.

In return, there is a very attractive salary, relocation expenses where appropriate, pension & life assurance scheme and excellent prospects for career development. The first part of the assignement will be based at the company's Fawdon Headquarters prior to the move to Alnwick.

To apply, please write with concise career details to

Colin Davison, Personnel Manager,
Sterling-Winthrop Research & Development,
Edgefield Avenue, Fawdon, Newcastle upon Tyne.

Applications are welcome from both men and women.

STERLING WINTHROP

HARPER ADAMS AGRICULTURAL COLLEGE,
NEWPORT, SHROPSHIRE

RE-ADVERTISEMENT

LECTURER GRADE I/GRADE II IN ANIMAL SCIENCE

Applications are invited for this additional post in the Animal Science Department which will become available from 1 January, 1981.

The successful applicant will be primarily responsible for teaching microbiology and aspects of animal health to BSc and HND Agriculture students. Candidates should have a degree in Animal Science, Veterinary Science or related subject. Post graduate or teaching experience is desirable.

The salary will be in the Burnham FE Scale:

Lecturer Grade I — £5034–£8658
Lecturer Grade II — £6462–£10 431

Point of entry dependent on qualifications and experience.

Further particulars and application form from: **The Principal, Harper Adams Agricultural College, Newport, Shropshire TF10 8NB.**

INNER LONDON EDUCATION AUTHORITY
HURLINGHAM SCHOOL,
Peterborough Road, London SW6 3ED
Telephone No. 731 2581

LABORATORY TECHNICIAN GRADE 3

For Science Department. Working in a team of three technicians responsible for the preparation of classes up to 'A' level standards.

Applicants should have ONC, OND, 2 'A' levels and some 'O' levels, Ordinary City and Guilds or equivalent qualifications and a minimum of 3 years experience (including training period).

Salary scale £4674–£5475 plus £1016 London Weighting.

Application forms are available from and returnable to the school within 14 days of the appearance of this advertisement.

Information Scientist

Hampshire

A challenging opportunity exists for an Information Scientist at the Group Research & Development Centre of British-American Tobacco Company in Southampton. The present information system makes use of a large, in-house computer, plus access to external data bases for the provision of a wide range of bibliographic and scientific information. This in-house computer is now available on-line to scientists and engineers working in research laboratories in the U.K., Europe and North America. There is now an urgent requirement to extend the use and scope of the present system, which has led to this new vacancy.

The ideal candidate will possess a good degree in science or engineering, a post graduate qualification in information science, and have experience in special library techniques and in handling information by computer. There will be substantial initial responsibility with the opportunity to progress quickly to head up the information and library services.

This is a position suited to a person of high ability and attracts an appropriately high salary. The Company will meet re-location expenses, where applicable, and operates a non-contributory pension scheme.

Candidates should write, enclosing a career summary, to: Mrs. J. A. R. Elsey,
Personnel Department (Folio 272),
Group Research & Development Centre,
British-American Tobacco Co. Ltd.,
Regent's Park Road,
SOUTHAMPTON SO9 1PE.
Alternatively telephone
Southampton 782111
(reversing the charges).

B·A·T

RESEARCH & DEVELOPMENT

UNIVERSITY OF STIRLING

RESEARCH ASSISTANT

CHEMISTRY DEPARTMENT

Applications are invited for the post of Research Assistant in the Chemistry Department to work with Prof. J. M. G. Cowie on Ionomeric Polymers. The period of appointment would be for 10 months at a salary of up to £6070 per annum.

Applicants with an honours degree or equivalent are invited to apply, giving names of 2 referees, to **The Secretary, University of Stirling, Stirling FK9 4LA. Closing date 12 October, 1981.**

KINGSTON POLYTECHNIC

School of Geography

SENIOR TECHNICIAN

The post involves oversight of and participation in technical work in the School, including preparation of laboratory and fieldwork materials, maintenance of equipment and keeping accurate records.

Applicants must have qualities of leadership, a practical inclination and an ability to improvise in the design and construction of small items of equipment. T3/4 grade £6135-£7620 inclusive. Application forms (to be returned by 16 October) and details from Assistant Registrar (Personnel), Kingston Polytechnic, Penrhyn Road, Kingston upon Thames. Tel: 01-549 1366.

EDITORIAL ASSISTANT

Editorial Assistant required by the Institute of Physics to work in its Publishing Division in Bristol. The Publishing Division is an international publisher of a wide range of primary research journals, review journals, professional magazines and books. Applicants should have A-level physics or mathematics (or an equivalent qualification). The successful candidate will work as part of a small team in a pleasant office.

Starting salary £4200 pa or £4500 pa if graduate.

For application form and further information please apply to:

Assistant Administrator, The Institute of Physics, Techno House, Redcliffe Way, Bristol BS1 6NX.

UNIVERSITY OF BATH

SCHOOL OF PHYSICS

POSTDOCTORAL RESEARCH OFFICER

Applications are invited to this two year SRC funded post to work on high pressure ultrasonic studies of soft phonon mode transitions in collaboration with Professor G. A. Saunders.

Applicants should have experimental experience in ultrasonics, high pressure or solid state physics.

Commencing salary up to £6880 p.a. according to qualifications and experience.

Application forms and further details from the **Personnel Officer, University of Bath, BATH BA2 7AY**, quoting ref. no: 81/112. Closing date: **19.10.81.**

University of Reading

Food Selection and Feeding Behaviour of Farmland Rabbits

Research Officer (funded by MAFF) required in Department of Agriculture & Horticulture for a fixed period of 3 years. The Officer will work closely with the MAFF team at their Worplesdon Laboratory. These studies will be an integral part of the total research programme. Long hours will need to be spent in the study areas. Candidates should have experience in ecology/behaviour and PhD or equivalent, and a valid car driving licence. Salary in range £6070-£10 575 pa. USS superannuation. Apply, quoting Ref: R.21A, for application form to **Personnel Office, University of Reading, Whiteknights, Reading RG6 2AH.**

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Department of Medical Biochemistry

SENIOR LECTURER AND LECTURER

Applications are invited from suitably qualified persons, regardless of sex, race, colour or national origin, for appointment to the above posts.

The incumbent will be expected to assist in the teaching of medical and science students. There is an active research programme in the department, which is well equipped.

The salary ranges attached to these posts will be as follows: Senior Lecturer: R18 075-R23 550 per annum. Lecturer: R11 435-R20 280 per annum.

Interested persons should obtain the information sheet relating to these posts from Miss J. Lloyd, South African Universities Office, Chichester House, 278 High Holborn, London WC1V 7HE, or from the Registrar (Staffing), University of the Witwatersrand, Jan Smuts Avenue, Johannesburg, South Africa 2001, quoting Ref 11/1/662, with whom applications should be lodged by 15 October, 1981.

INSTITUTE OF CANCER RESEARCH

A vacancy has arisen for a

POSTDOCTORAL RESEARCH SCIENTIST

to take part in an existing programme of research into ligand-arming as a means of preparing new anti-cancer drugs. The candidate should have experience with tissue culture methods and considerable dedication to the notion of attacking cancer cells. The post will be jointly in the Departments of Chemistry and Biology at the Institute of Cancer Research (Chester Beatty Research Institute), Fulham Road, London SW3. The post will be available immediately and for a period of two years. The salary will accord with MRC scales in the range £6070-£9750 pa according to age and experience, plus London Allowance of £967 pa.

Applications in duplicate with the names of two referees to the Secretary, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting ref. 300/G/9.

MRC

Medical Research Council Centre

LABORATORY OF MOLECULAR BIOLOGY

A RESEARCH ASSISTANT

is required for work involving electron microscopy of muscle proteins and related material. Experience in electron microsscopy or biochemistry would be an advantage.

Salary on scales from £2571, £2943 or £4677 per annum depending on qualifications and experience, with opportunities for further study if appointed to one of the lower two scales.

Applications in writing within the next two weeks, with CV and names of two referees, and quoting reference number SS/6 to: **The Administrator, MRC Centre, University Medical School, Hills Road, Cambridge CB2 2QH.**

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FELLOWSHIPS, GRANTS, SCHOLARSHIPS

UNIVERSITY OF YORK

Cancer Research Unit

RESEARCH FELLOWSHIP (POSTGRADUATE OR POSTDOCTORAL)

An interesting opportunity exists in the above Unit for a synthetic/organic chemist to work on various aspects of environmental pollution. Applicants should have a sound knowledge of practical organic synthesis as well as experience of analytical procedures.

The post is tenable for three years and is funded by the Health and Safety Executive. The salary will be on Scale IA for research and allied staff depending on qualifications and experience. (Present range £6070-£10 575).

Previous applicants need not reapply.

Four copies of applications, including full curriculum vitae and naming three referees, should be sent by Monday 19 October 1981 to the Registrar, University of York, Heslington, York, YO1 5DD, from whom further particulars may be obtained. Please quote reference NS/7099.

UNIVERSITY OF EDINBURGH

POSTDOCTORAL RESEARCH FELLOW

Applications are invited for this post, tenable for a maximum of three years, supported by a grant from the Medical Research Council. The work involves human breast tissue and the project examines responses to menstrual cycles, parity and age, with relevance to development of breast cancer. Applicants should have a PhD or equivalent and have experience in electron microscopy. Salary scale is range IA, starting point up to a maximum of £6880. Applications, including name and address of three referees, should be sent to **Dr T. J. Anderson, Department of Pathology, University of Edinburgh Medical School, Teviot Place, Edinburgh EH8 9AG** not later than 23 October, 1981. Please quote reference 5057.

UNIVERSITY OF BIRMINGHAM

Department of Chemical Engineering

RESEARCH FELLOWSHIP

Applications invited for this SERC-funded post to work on mixing, gas-liquid mass transfer and rheology. The work is particularly related to the fermentation of Xanthan gum. Experience in fluid mixing processes in agitated vessels and rheology is essential.

The post is tenable for 9 months. Salary on Research Fellow IA scale £6070-£10 575 plus superannuation. Maximum starting salary £6880.

Further particulars from Assistant Registrar (Sci. & Eng.), PO Box 363, Birmingham B15 2TT, to whom application (three copies) including full curriculum vitae and naming three referees should be sent by Wednesday 21 October 1981. Please quote ref: NST2(r).

THE ROYAL SOCIETY

THE RUTHERFORD SCHOLARSHIP

This award, for graduates of exceptional promise and ability who are under 26 years of age on 1 May, 1982, is for experimental research in any branch of the natural sciences, with a preference for experimental physics if there are candidates of similar merit. It will be tenable for three years, from 1 October, 1982 or such other date as may be arranged, in some part of the British Commonwealth other than that in which the applicant graduated. The value, adjusted to meet the circumstances, will be £3350 per annum on appointment (under review) if held in the United Kingdom, with allowances for travel, university fees, etc. It will not normally be awarded to a graduate who has already held a senior research award.

Applications should be made as follows:

From university graduates in the United Kingdom: before 15 February, 1982 on forms obtainable from the Executive Secretary, The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG.

From university graduates outside the United Kingdom: through their universities to the Royal Commission for the Exhibition of 1851 on forms of application for the Commissioners' Science Research Scholarship to be obtained from the registrars or administrative authorities of their universities.

LEICESTER POLYTECHNIC

School of Chemistry

POSTDOCTORAL FELLOWSHIP

Applications invited for a postdoctoral appointment tenable in the School of Chemistry, for Studies in the Synthesis of novel biologically active compounds in collaboration with Dr A. F. Temple and The Boots Co Ltd. Candidates with an interest in and experience of synthetic organic chemistry should be about to submit or have recently submitted for PhD. It is anticipated that the appointee will maintain a close liaison with the sponsoring company and will have the opportunity of gaining experience of the wider aspects of drug research.

The appointment will, in the first instance, be a one year contract with possible extension to a maximum of two and a half years; the salary will be in the range, £6070-£6880 per annum.

Application forms and further particulars available from Personnel Officer, Leicester Polytechnic, PO Box 143, Leicester LE1 9BH. Tel (0553) 551551, ext 2303/1.

UNIVERSITY OF BIRMINGHAM

Department of Biochemistry

RESEARCH FELLOWSHIP

Applications are invited for a Research Fellowship for three years to work with Dr N. J. Kuhn on an ARC sponsored project to establish and biochemically study mammary epithelial monolayers on floating collagen cells. Applicants should have suitable postgraduate experience, preferably including cell culture.

Salary within the range £6070-£10 575 but initial salary not expected to exceed £6880, depending on age, qualifications and experience.

Applications (2 copies) including a curriculum vitae and the names of three academic referees, should be sent by 30 October 1981 to Jane Netson, Senate Registry, University of Birmingham, PO Box 363, Birmingham B15 2TT, from whom further particulars may be obtained.

STUDENTSHIPS

UNIVERSITY OF BATH

School of Biological Sciences

SRC CASE STUDENTSHIP

Applications are invited from graduates with an upper second or first class degree in Plant Sciences or a related subject for a CASE Studentship to study the effects of virus infection on clonal variation in woody ornamentals.

The work will be done in collaboration with Long Asbton Research Station and the joint Horticultural Trades Association/National Farmers' Union Nursery Stock Committee.

Applicants should send a curriculum vitae and the names and addresses of two referees to: Dr R. G. T. Hicks, School of Biological Sciences, University of Bath, Claverton Down, Bath BA2 7AY, from whom further details may be obtained.

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My God! It's just worked out I can't afford to use it.

WE CAN all relax and have another drink, stop worrying and love the bomb. By special request and public clamour, the forthcoming attraction on this planet, with cast of millions is—let's have a big hand—civilised warfare!

The welcome return of this star of previous ages has been forecast by Samuel Cohen, one of the team who appeared in the well-reviewed but short-running show, *The Manhattan Project*. In all past conventional wars, according to Cohen, the reason for using weapons was to kill people. Unfortunately, they did not always do this. They could simply maim. (Cue for hit song of the new show, *"Ain't it a shame about Maim"*.)

With the neutron bomb, soldiers receiving quite large doses of radiation could recover without harm, or not much. Cohen said that in civilised wars the key feature was the protective wall of a city and all wars were fought outside it, leaving civilians safe. (Big transformation scene, with special civilised effects designed by Attila Sacking and Pillaging, Inc.) It seems to me that Cohen should read some history, even recent history. ☐

DEPRESSINGLY, a bandwagon is rolling, I think. There are few people more prone to leap on one than lecturers and lecturers about science in particular. The bandwagon is carrying Pandora's box. In recent weeks the box has figured in more talks than I want to recall. "If we open that Pandora's box," "That would be opening a Pandora's box" and so on, *ad nauseam*.

For the information of all and sundry, the box was opened, long ago, by, of all characters, Pandora. Hence all the evils of the world, which fled out to wreak their worst on mankind when she opened the lid. Some versions of this event say that she managed to shut the lid before hope escaped, too. Others say that not a thing was left. I prefer the first versions. But it's no good carrying on about Pandora's box now. Any contemporary ones are spurious, fakes, rigged up for rhetoric. ☐

BRIGHTON, that peerless (and in future maybe pierless) resort, has a railway station, controlled by an organisation called British Rail. This outfit also controls the bars there. In one, a visiting scientist asked for a shandy. "We don't serve shandy here," said the alleged servitrix behind the counter. "Do you have lemonade?" asked the scientist.

She produced one. He thereupon ordered a beer, drank some of it, poured in lemonade and said, "That's how you make a shandy."

It is scientific training that counts. ☐

SOME London parks allow motor cars to drive through and some allow cars to park. Most cars nowadays have radios. It is a fearsome combination.

All London parks have laws about playing radios in them. The laws are simple. No radios are allowed to be played. These laws, along with others about dogs, fires and so on, are displayed on notice boards at the entrances to the parks. But usually these are entrances for people on foot and, in any case, the notices will not be read by anyone in a car even if they are alongside a car entrance.

There seems to me every case for an internationally recognised sign. Motorists are used to these. A picture of a radio with a red line through it should do the trick and save parks all over the world from the row.

Of course, the park police in London are nothing if not deaf. I have seen a park policeman walk slowly by a motorist, all doors open, giving everyone within 50 metres the benefit of his radio. If parks are not to be desecrated with noise the police will have to start recruiting people with normal hearing. There are few enough places left where silence is the rule. ☐

I CONFESS that I have been a fan of Heinz Wolff's for a long time, for a particular reason. He has the rare ability to put perception into plain language. Mr Wolff is the head of bioengineering at the MRC's Clinical Research Centre and I quote typical remarks from him on the problems of disability. "None of us has the ability to push a finger into a brick wall to make a hole and we think it perfectly natural to acquire this ability by buying a drill. Why should a person with arthritis, who has difficulty in getting his key in the door not be able equally, as a matter of course, to buy a tool to help him do that?"

That passage seems to me to contain much sense. It also implies concern and the idea that disability should, in a way, be treated as normal or common, as in a way it is.

I have some experience of the psychological effects of disability. It can ruin a sensitive person's social life—for example, a dinner party may be hell for someone whose hands are distorted by arthritis, not only because of the difficulty of handling cutlery, but also their reluctance to have their hands in view. ☐

ALL BIOLOGICAL material could in principle be eaten, even though much of it is repulsive or indigestible to human stomachs. Digestion is essentially just hydrolysis. By reaction with water, proteins are broken down into their individual amino acids, saccharides into simple sugars, and fats into glycerol and fatty acids. So Daedalus is devising a prototype universal digester which will hydrolyse any biological material whatever, using hot water under great pressure and a little acid catalysis. Its first use will be to reclaim waste food—offal, old cabbage stalks, potato peelings and the like, but this is only the beginning. Wood, leather, condemned carcasses, rotted compost, paper, old clothes, seaweed, feathers, are all grist to this mill. It will not matter if they are heavily infested with bacteria, or even rats; they will be hydrolysed too. The nearly supercritical water should be a perfect solvent for all the hydrolysis products, even the fatty acids, so a simple filtering from non-biological contaminants (buttons, nails etc) will yield a clear and sterile solution. It will be evaporated to small bulk, when the molecular equilibria will shift towards recombination again. The amino acids will yield weird gooey proteins, the fatty acids will become "averaged" fats; even the sugars may begin to link up. The resulting bland nutritive jelly will be DREADCO's "Hydromass", the universal pabulum.

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